Beware the Side Effects: Capital Controls, Misallocation and Welfare *

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Abstract

We study the effects of capital controls through the lens of a dynamic model with heterogeneous firms, monopolistic competition, endogenous trade participation and financial frictions. A tax on foreign borrowing worsens misallocation via static effects that reduce capital-labor ratios and increase firm prices. Dynamic effects reduce it via stronger saving incentives and general equilibrium effects worsen it by reducing aggregate prices and output. Quantitative analysis calibrated to the 1990s Chilean *encaje* predicts higher misallocation with larger effects on high-productivity exporting or young firms that depend more on debt. Social welfare falls sharply, by 2.39%, due to large general equilibrium effects. The costs for high-productivity firms are twice as large. Using an interest-rate hike (a tighter LTV requirement) instead of capital controls yields larger (smaller) effects. Empirical evidence derived from Chilean firm-level data shows that the *encaje* did increase misallocation and significantly more for high-productivity exporting or young firms.

Keywords: Capital controls, welfare, misallocation, financial frictions, international trade.

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1 Introduction

Capital controls (CCs) were implemented in several emerging economies through the 1990s to counteract credit booms and other financial vulnerabilities arising from surging capital inflows. After the 2008 Global Financial Crisis, they attracted more attention and became part of the toolbox of macroprudential policies to reduce systemic financial risk and contagion. New research provided theoretical arguments favoring the macroprudential use of CCs as a tool for removing pecuniary externalities that cause overborrowing and sudden stops through credit constraints linked to collateral prices (e.g. Bianchi and Mendoza (2018)).

From the point of view of non-financial firms, however, CCs increase the interest rate at which they borrow, making external financing more expensive. Hence, as has also been noted in research and policy circles, macroprudential policies entail potentially costly tradeoffs, because they distort investment in a manner akin to a capital income tax. In the context of representative-agent models, research shows that, unless CCs are sufficiently state-contingent, they remain in place in states in which taxing investment is inefficient (see Bianchi and Mendoza (2020) and Darracq-Paries et al. (2019)). There is also important empirical evidence showing that CCs affect firms differently depending on characteristics such as size, financial dependence or capital intensity (Alfaro et al. (2017), Forbes (2007), Andreasen et al. (2020)). Thus, the data indicate that there is an important transmission mechanism by which CCs affect firm dynamics and firm heterogeneity, but to date little is known about the nature of this transmission mechanism and its positive and normative implications.

Two key questions remain unanswered: What are the "side effects" of CCs on the allocation of productive factors across firms? And, what are the social welfare implications of these side effects? This paper provides theoretical, quantitative and empirical answers to these questions by studying the effects of CCs on misallocation and welfare in a dynamic model with monopolistically-competitive heterogeneous firms that face credit constraints and can choose whether to enter export markets.[1]

A continuum of risk-averse, heterogeneous entrepreneurs produce differentiated domestic varieties of intermediate goods and sell them to final-good producers domestically and, potentially, abroad. Entrepreneurs differ in their exogenous idiosyncratic productivity

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[1] We focus on the case of capital controls, but the model is also applicable to analyze two other important questions, namely the misallocation effects of financial repression and financial integration.

draw, the size of their capital stock, and whether they sell abroad or not. They can save and borrow internationally, but they face a collateral constraint when they borrow. CCs are modeled as a tax on foreign borrowing (i.e., an asymmetric tax), affecting all firms that rely on this form of financing by increasing the effective interest rate on their debt. The CCs thus add to the financial frictions already present because of the collateral constraint.

In the model, absent collateral constraints and CCs, there is no misallocation in the decentralized equilibrium: the marginal revenue products of capital (MRPK) and labor (MRPL) are equalized across firms, and the MRPKs are also equal to the world opportunity cost of capital, irrespective of the firms' idiosyncratic productivity or exporting status. In the presence of at least one of the financial distortions, however, there is dispersion in the MRPK across firms and thus misallocation arises. This occurs because financial distortions prevent firms from producing at their optimal level of factor demands, causing inputs to be assigned inefficiently across heterogeneous production units.

The model predicts that introducing CCs to an economy with collateral constraints affects misallocation through "static" effects, namely responses of firms' capital, labor, production and pricing choices to the introduction of the debt tax taking as given aggregate variables, net worth and saving plans. We show that these effects worsen misallocation when CCs are introduced by tightening the firms' financial constraints, which reduces their capital and capital-labor ratios and increases their prices, and consequently increases their MRPKs. There are also, however, general equilibrium and dynamic effects at work. The former result from changes in aggregate variables, particularly wages and the output and price of final goods, which change as CCs affect the distribution of firms and the misallocation of capital across firms and therefore aggregate demand for final goods and supply of intermediate goods. Dynamic effects are driven by an "oversaving" distortion due to stronger saving incentives, because tighter financial constraints increase the marginal return on saving and thus incentivize entrepreneurs to growth their net worth faster. Hence, firms for a given net worth have higher MRPK because of the static effects when CCs are introduced, but in the stationary distribution of firms there may be more firms at higher levels of net worth where MRPKs are lower (i.e., relative to the economy with just collateral constraints, CCs increase MRPK for some firms but lower it for others). As a result, the net effect on misallocation and thus on welfare is ambiguous.[2]

We derive the model's quantitative predictions by comparing stationary equilibria before and after the imposition of capital controls for a calibration based on a well-defined natural experiment: the case of the Chilean *encaje* (i.e., a 30% unremunerated reserve requirement on foreign inflows imposed between 1991 and 1998). We calibrate the model to pre-*encaje* Chilean data and then introduce an estimate of a tax on foreign debt that is equivalent to the *encaje* in terms of its impact on borrowing costs. Misallocation is measured as the standard deviation of MRPKs relative to their efficient level in the stationary distribution of firms.

The model predicts that, while in the aggregate across all firms misallocation increased slightly (0.11%), misallocation worsened significantly for high-productivity exporters (5.34%) that are about 18% of all firms. This occurs because they have larger optimal scales and hence rely more on credit to accumulate capital and to pay the fixed cost of entering export markets. Misallocation also increased for high-productivity young firms (0.38%), as they are still trying to reach their optimal scales and are therefore more exposed to the effect of CCs on borrowing costs. In contrast, misallocation decreased for all low-productivity firms (-0.79%) and for high-productivity non-exporters (-2.73%), because they have smaller optimal scales and need to borrow less to reach them.

CCs reduce social welfare significantly, by an amount equivalent to a permanent cut of 2.39% in consumption of all entrepreneurs (using a utilitarian social welfare function that aggregates lifetime utility of entrepreneurs using the model's stationary distribution). Entrepreneurs that operate high-productivity firms are much more affected, showing a welfare cost of 3.52%, while those running low-productivity firms suffer a loss of 1.65%, which is still large but about half the loss of high-productivity entrepreneurs. This difference reflects the result that CCs have stronger misallocation effects on high-productivity firms. Decomposing the social welfare loss into a component due to reallocation of aggregate consumption across entrepreneurs and a component due to changes in aggregate consumption, we found that the latter dwarfs the former. In fact, consumption is slightly more equally distributed with CCs. Social welfare falls sharply due to strong general equilibrium effects of the heterogeneous mis-

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[2] Since the collateral constraint alone causes misallocation, CCs introduce an additional source of misallocation into an economy that was already inefficient. As inefficient equilibria cannot be ranked in general, the social welfare effect of CCs is theoretically ambiguous.

allocation responses of firms that cause declines of 3% and 2.7% in output of final goods and aggregate consumption, respectively. Importantly, the social welfare loss is not due to the representative-agent investment wedge, but to the aggregate effects of the large increase in MRPKs of high-productivity firms. These results are robust to whether we assume that the revenue generated by the debt tax is a resource loss to entrepreneurs (the baseline case) or rebated to them as a lump-sum transfer that matches the tax bill paid by each, although the model with rebates generates smaller welfare costs. The social welfare loss falls slightly to -2.14%.

These results indicate that there is a non-trivial misallocation tradeoff in the use of CCs to restrain credit. This led us to examine the implications of two alternative policies that reduce the ratio of aggregate credit to value added in the same magnitude as in the CCs experiment: a symmetric increase in the interest rate and a cut in the fraction of capital that firms can pledge as collateral, that is, a tighter loan-to-value (LTV) requirement. The first policy lowers the optimal scale of all firms, which in turn generates more misallocation and larger welfare costs than in the case of the CC. In contrast, the LTV yields less misallocation and lower welfare costs than the CC. This is due to the fact that the tighter LTV affects only firms that are credit constrained, and thus affects mainly the speed at which firms accumulate capital.

The model's quantitative predictions show an adverse effect of capital controls on misallocation that is significantly larger for high-productivity firms, and among those, for exporters and young firms. If these effects are empirically relevant, they should be observable in the data. Hence, we conducted an empirical analysis to determine whether this is the case. We constructed a panel of Chilean manufacturing firm data from 1990 to 2007 using the *Encuesta Nacional Industrial Anual* (ENIA). Following Bai et al. (2020), we defined misallocation at the firm-level as the absolute value of the difference, in each period, between the firm's MRPK to the mean MRPK of the industry.In line with the model's results, CCs produce a statistically significant increase in misallocation that is relatively larger for more productive firms that are exporters or younger.

The rest of the paper is organized as follows: Section 2 places the contributions of our work in the context of the related literature. Section 3 presents the theoretical model and derives its key implications. Section 4 discusses the quantitative results. Section 5 conducts the panel-data analysis and discusses its findings. Section 6 concludes.

2 Related Literature

This paper is related to three strands of the literature. First, studies that explore the link between misallocation and financial frictions. Second, research on the trade effects of misallocation. Third, studies on the firm-level implications of capital controls.

Studies of misallocation and financial frictions use heterogeneous-firms models to study and quantify how policies and firm characteristics generate misallocation (e.g., Restuccia and Rogerson (2008), Hsieh and Klenow (2009)). Several of these studies focus on closed-economy models under perfect competition. Buera et al. (2011) proposed a model with sectors that differ in their degree of financial dependence and show that financial frictions can significantly distort the allocation of productive factors. Midrigan and Xu (2014) propose a model with traditional and modern productive sectors in which debt constraints distort technology adoption decisions and create misallocation. Both models predict that financial liberalization reduces misallocation. Buera and Moll (2015) examine how shocks to a collateral constraint under three forms of heterogeneity affect aggregate wedges used to account for aggregate fluctuations. Our work differs from these studies in that we examine an open-economy model, which links efficient levels of MRPK to world opportunity costs, and assume monopolistic competition, which amplifies MRPK effects.

Gopinath et al. (2017) propose an open-economy model with monopolistic competition and a collateral constraint that is an increasing, convex function of a firm's capital. They show that a decline in interest rates can lead to a sharp decline in sectoral total factor productivity as capital inflows are misallocated towards firms that have higher net worth but are not necessarily more productive. They document capital misallocation and productivity losses in Spain, Portugal and Italy during a period of declining real interest rates but not in Germany, France, and Norway. They focus on partial-equilibrium analysis. Our work is similar in that we also study an open-economy model with monopolistic competition, but differs in that we use a standard collateral constraint linear in capital, introduce endogenous trade participation, and examine general equilibrium outcomes (with the finding that general equilibrium effects play a key role in determining the misallocation and welfare effects of capital controls). Our work also contrasts with these closed- and open-economy studies in that we study the social welfare implications of misallocation.

There are also several empirical papers that focus on the relation between capital controls and TFP across firms. Bekaert et al. (2011) demonstrate that the easing of CCs positively affects capital stock growth and TFP. Larraín and Stumpner (2017), focusing on Eastern European countries, find that capital account liberalization increases aggregate productivity through a more efficient allocation of capital across firms. Related to this, Varela (2018) studies the financial liberalization episode of Hungary in 2001 and shows that a reduction in CCs can lead firms to invest in technology adoption and, through this channel, aggregate TFP increases. Some papers study the Chilean case. Oberfield (2013) examines allocative efficiency and TFP during the 1982 financial crisis. He finds that within-industry TFP either remained constant or improved in 1982, while a decline in between-industry allocative efficiency accounts for about one-third of the reduction in TFP. Chen and Irarrázabal (2015) provide suggestive evidence that financial development might be an important factor explaining growth in output and productivity in Chile between 1983 and 1996. Pavcnik (2002) investigates the effects of trade liberalization on plant productivity in Chile in the early 1980s. Our paper contributes to this empirical literature by examining the effects of the Chilean *encaje* on misallocation using a large panel dataset for manufacturing establishments and showing that it increased misallocation and significantly more for high-productivity exporting and young firms.

Regarding studies of misallocation and the trade margin, Berthou et al. (2018) study the impact of international trade on aggregate productivity. They show that trade reforms such as bilateral and unilateral export liberalization have ambiguous effects on welfare and productivity in the presence of misallocation. Using data for 14 European countries and 20 manufacturing industries during 1998-2011 they document that export expansion and import penetration increases aggregate productivity. However, the productivity gains work through different channels. Export growth induces higher average productivity and a reallocation towards more productive firms. Imports, on the other hand, improve competition and raise average firm productivity. Bai et al. (2020) incorporate firm-level distortions into a Melitz model and characterize welfare under misallocation. They find that, contrary to the Melitz (2003) model where trade induces a reallocation from low- to high-productivity firms, the presence of distortions can bring out the opposite and exacerbate misallocation. They use Chinese manufacturing data and contrast the key implications of the model. Our paper is closely related to Andreasen et al. (2020). They build a general equilibrium model with heterogeneous firms, financial constraints and international trade and calibrate it to the Chilean economy. The model predicts that capital controls reduce aggregate production and investment while increasing exports, the share of exporters and TFP. The effects of capital controls are exacerbated for firms in more capital-intensive sectors and for exporters. We add to this literature by studying how capital control affects trade and misallocation in an economy that is already distorted by the presence of credit constraints.

Finally, our paper relates to the literature that studies the firm-level implications of capital controls. Alfaro et al. (2017) find a decline in cumulative abnormal returns for Brazilian firms following the imposition of CCs in 2008-2009, they also find that this effect is stronger for smaller, non-exporting and more financially dependent firms. For the specific case of the Chilean encaje, Forbes (2007) finds that smaller firms experienced significant financial constraints, which decreased with firm size. We add to this literature by considering the effects of capital controls on resource allocation.

3 Model

We study the effect of capital controls on misallocation and welfare in a dynamic general equilibrium model with heterogeneous entrepreneurs and financial frictions in the spirit of Midrigan and Xu (2014), Buera and Moll (2015) and Gopinath et al. (2017). In the model, entrepreneurs sell differentiated varieties of intermediate goods to both domestic and foreign final-goods producers in monopolistically competitive markets. They have access to foreign financing but face financial frictions in the form of a collateral constraint and (if present) capital controls. They can also choose whether to become exporters by paying an entry cost in units of labor. Financial frictions generate misallocation through three channels. First, the collateral constraint creates dispersion in MRPKs as in the related literature. Constrained firms cannot reach their steady-state capital stock immediately and display larger misallocation the more constrained they are. Second, if CCs are present, the dispersion of MRPKs is affected by a higher, tax-distorted interest rate for all firms that borrow, whether their borrowing is constrained or not. Third, the entry cost to become an exporter implies that firms need to accumulate enough assets to find it optimal to participate in external trade. CCs on capital inflows are introduced as a tax on foreign borrowing aimed at capturing the main features of the Chilean *encaje*.[3]

3.1 Final-goods sector

A representative producer of final goods purchases differentiated varieties of intermediate goods from domestic and foreign entrepreneurs and uses them as inputs to operate a constant-elasticity-of-substitution (CES) production technology. The elasticity of substitution across all inputs is denoted by $\sigma > 1$. Let the set $[0,1]$ index the measure of entrepreneurs in the domestic economy and define $\{p_{h,t}(i)\}_{i\in[0,1]}$ and p_m as the prices charged by domestic and foreign entrepreneurs, respectively. The producer of final goods chooses the optimum bundle of domestic, $\{y_{h,t}(i)\}_{i\in[0,1]}$, and imported, $y_{m,t}$, inputs so as to maximize profits from final-goods production, y_t, taking all input prices as given and subject to the CES technology:

$$\max_{y_{h,t}(i),y_{m,t}} \; p_t y_t - \int_0^1 p_{h,t}(i) y_{h,t}(i) di - p_m y_{m,t},$$

$$\text{s.t.} \qquad y_t = \left[\int_0^1 y_{h,t}(i)^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where eq. (1) is the CES production function and p_t is the CES price index of final goods, $p_t = [\int_0^1 p_{h,t}(i)^{1-\sigma} di + p_m^{1-\sigma}]^{1/(1-\sigma)}$. This problem yields standard results by which the final goods producer demands each input up to the point where its marginal product equals its corresponding market price, which is its marginal cost.

3.2 Intermediate-goods sector

Risk-averse entrepreneurs produce differentiated varieties of intermediate goods and supply one unit of labor inelastically. They sell their goods in monopolistically competitive markets at home and, if they are exporters, abroad. Preferences of an entrepreneur $i \in [0,1]$ are:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma},$$

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[3] We explain the main features of the Chilean *encaje* in Appendix A.

where c_t is consumption, γ is the coefficient of relative risk aversion, and β is the subjective discount factor. The expectation $\mathbb{E}_0$ is taken over the possibility of death, which happens with probability ρ. At the end of the period, deceased entrepreneurs are replaced by a measure ρ of newborn entrepreneurs. In order to insure against the probability of death, entrepreneurs engage in an annuity contract by which, in the case of death, all savings and capital are transferred to existing entrepreneurs. This annuity pays surviving entrepreneurs an amount that expands their accumulated net worth by a proportion $\frac{\rho}{1-\rho}$.[4]

Entrepreneurs make a choice to remain non-exporters ($e = 0$) or become exporters ($e = 1$) at the beginning of each period. The choice to be an exporter is irreversible, but an entrepreneur who chooses to remain a non-exporter retains the option to become an exporter in the future. If the entrepreneur chooses to become an exporter, it pays a one-time entry cost F in units of labor at t and starts exporting at $t + 1$. Exporting goods also incurs an "iceberg" trade cost that requires exporters to ship τ units of intermediate goods for every unit that is sold abroad each period, with $\tau > 1$.

Since entrepreneurs are monopolistic competitors, an entrepreneur $i \in [0, 1]$ faces the following domestic demand function for its particular input variety:

$$y_{h,t}(i) = \left(\frac{p_{h,t}(i)}{p_t}\right)^{-\sigma} y_t, \tag{2}$$

Entrepreneurs who export also face this foreign demand function:

$$y_{f,t}(i) = \left(\frac{p_{f,t}(i)}{p^*}\right)^{-\sigma} y^*, \tag{3}$$

where $p_{f,t}(i)$ is the price the entrepreneur charges for its input variety abroad, and p^* and y^* are the exogenous price index and output of foreign final goods, respectively.

Newborn entrepreneurs arrive with zero debt, receive a transfer of capital from the government $\underline{k}$ and draw idiosyncratic productivity z that remains constant throughout their lifetime. z has a log-normal probability distribution function $f(z)$ with mean μ_z and standard deviation ω_z. Entrepreneurs operate a Cobb-Douglas technology that is a function of their

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[4] We introduce this annuity contract for tractability. It effectively removes uncertainty and risk from the entrepreneur's optimization problem. We acknowledge, however, that this implies assuming the existence of a well-developed annuity market that is somewhat at odds with assuming collateral constraints.

productivity z, their capital stock k_t, the labor they hire n_t, and the technology's capital intensity $\alpha \in (0,1)$. Hence, market-clearing in the market of each input variety requires:

$$y_{h,t} + e(\tau y_{f,t}) = z k_t^{\alpha} n_t^{1-\alpha}. \tag{4}$$

Capital depreciates at rate δ and investment is denoted x_t. Taking into account the annuity payments, the law of motion of capital is given by:[5]

$$k_{t+1} = \frac{1}{1-\rho}[(1-\delta)k_t + x_t]. \tag{5}$$

Entrepreneurs participate in a global market of one-period, risk-free discount bonds. d_{t+1} denotes debt issued (bonds sold) at date t to be repaid at t+1.[6] They also face a collateral constraint by which they cannot borrow more than a fraction $0 \leq \theta \leq 1$ of the value of the capital stock they have available when the debt is due for repayment:

$$d_{t+1} \leq \theta k_{t+1}. \tag{6}$$

Without capital controls, the gross interest rate on these bonds is the world real interest rate $R^* \equiv 1 + r^*$ and their price is $q^* = 1/R^*$. To match the Chilean *encaje* episode, we model capital controls as an asymmetric tax on external borrowing: for $d_{t+1} > 0$, the interest rate is $\hat{r} = r^* + \nu$ with a corresponding bond price $\hat{q} \equiv 1/(1+\hat{r})$, where ν is the tax-equivalent capital control on inflows with m-month maturity, and for $d_{t+1} \leq 0$ the interest rate is $r = r^*$ with bond price q^*.[7] Hence, bond prices are by given $q = \mathbb{1}_{d' \leq 0} q^* + \mathbb{1}_{d'>0} \hat{q}$.

We follow an approach similar to Buera and Moll (2015) to characterize the entrepreneurs' optimization problem in recursive form.[8] In particular, we define the relevant state variable as the entrepreneur's cash on hand $m \equiv [w + \frac{p_h^{1-\sigma}}{p^{-\sigma}} y + e \frac{p_f^{1-\sigma}}{p^{*-\sigma}} y^* - wn + p(1-$

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[5] The entrepreneur accumulates capital by the amount $(1-\delta)k_t + x_t$ and receives an extra $\frac{\rho}{1-\rho}[(1-\delta)k_t + x_t]$ from the annuity, which yields $k_{t+1} = \frac{1}{1-\rho}[(1-\delta)k_t + x_t]$.

[6] The debt is assumed to be denominated in units of domestic final goods for simplicity. We could assume that risk-neutral banks intermediate foreign debt that pays a real rate of r^* in units of p^* and that $p^* = 1$. Since our analysis focuses on the stationary equilibrium where p_t is constant, the no arbitrage condition of banks would imply $r = r^*$.

[7] We will consider capital inflows with a 12-month maturity in our benchmark quantitative exercise. See Appendix B for details of how the tax-equivalent measure of the Chilean encaje was constructed.

[8] Because of the monopolistic competition, however, in our setting the firms' profits and their debt and capital choices are not linear in net worth, and hence the net worth decision rule is not linear in cash on hand.

$\delta)k - pd - T]/p$ and define a' as its net worth $a' \equiv k' - qd'$. Hence, the budget constraint of the entrepreneur can be expressed as $c = m - (1-\rho)a'$.[9] The entrepreneur's optimal plans can then be formulated as a solution to a two-stage budgeting problem: An optimal choice of a' to maximize lifetime utility and a "static" choice to maximize m' by allocating allocating a' into a portfolio of k' and d' and setting p'_h, p'_f and n'.

At the beginning of the period, an entrepreneur who is not an exporter and drew productivity z at birth chooses whether or not to switch to become an exporter by selecting the option with the highest payoff:

$$v(m,z) = \max_{e \in \{0,1\}} \left\{ (1-e)v^{NE}(m,z) + ev^{S}(m,z) \right\} \tag{7}$$

where $v^{NE}(m,z)$ is the value of continuing as a non-exporter and $v^{S}(m,z)$ is the value of switching to be an exporter. Note that z does not vary over time. The dependence of these payoff on z reflects only differences across firms in the one-time productivity draw "at birth."

$v^{NE}(m,z)$ solves the following two-stage optimization problem:

$$v^{NE}(m,z) = \max_{a'} \left[u\left(m - (1-\rho)a'\right) + \tilde{\beta} v\left(\tilde{m}'(a',z), z\right) \right] \tag{8}$$

$$\tilde{m}'(a',z) = \max_{k',d',p'_h,n'} \left[\frac{w' + \frac{{p'}_h^{1-\sigma}}{p'^{-\sigma}} y' - w'n' + p'(1-\delta)k' - p'd' - T}{p'} \right] \tag{9}$$

$$\text{s.t.} \qquad \left(\frac{p'_h}{p'}\right)^{-\sigma} y' = z k'^{\alpha} n'^{1-\alpha} \tag{10}$$

$$a' = k' - d' \tag{11}$$

$$d' \leq \theta k' \tag{12}$$

where $\tilde{\beta} \equiv \beta(1-\rho)$. The value function in the right-hand-side of (8) is $v(\cdot)$ because the non-exporter entrepreneur retains the option to become an exporter in the future. The two-

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[9] The entrepreneur's budget constraint is $pc + p[(1-\rho)k' - (1-\delta)k] + pd + wn = w + p_h y_h + e(p_f y_f) + p(1-\rho)qd' - T$. Using the definition of a' and rearranging terms yields $pc + p(1-\rho)a' - p(1-\delta)k + pd + wn = w + p_h y_h + e(p_f y_f) - T$. Then using the demand functions (2)-(3) and rearranging terms yields $pc = w + \frac{p_h^{1-\sigma}}{p^{-\sigma}} y + e\frac{p_f^{1-\sigma}}{p^{*-\sigma}} y^* - wn + p(1-\delta)k + pd - T - p(1-\rho)a'$. Finally, applying the definition of m and dividing through by p yields $c = m - (1-\rho)a'$. Notice that a' is multiplied by $1-\rho$ because the annuity contract transfers all savings and capital to existing entrepreneurs, so $1-\rho$ multiplies both k' and a'.

stage-budgeting structure of the solution is evident in that this dynamic programming problem yields the decision rule $a'(m,z)$ that drives the evolution of net worth as a function of cash on hand, while the solution to the maximization problem defined by (9)-(12) determines $\tilde{m}'$, the optimal portfolio allocation of a' into k' and d' and the optimal ${p'}_h$ and n', all as recursive functions of (a',z). Hence, evaluating a' at the optimal value given by $a'(m,z)$, we can express these decision rules as $\tilde{m}'(m,z)$, $k'(m,z)$, $d'(m,z)$, ${p'}_h(m,z)$ and $n'(m,z)$. These decision rules depend also on the aggregate variables (y',p',w'), but we do not carry them as state variables to keep the notation simple, since we will solve for stationary equilibria in which they are time-invariant.

The value of a firm that is already exporting is:

$$v^E(m,z) = \max_{a'} \Big[u\left(m-(1-\rho)a'\right) + \tilde{\beta} v^E\left(\tilde{m}'(a',z),z\right) \Big] \tag{13}$$

$$\tilde{m}'(a',z) = \max_{k',d',{p'}_h,{p'}_f,n'} \left[\frac{w' + \frac{{p'}_h^{1-\sigma}}{p'^{-\sigma}} y' + \frac{{p'}_f^{1-\sigma}}{p^{*-\sigma}} y^* - w'n' + p'(1-\delta)k' - p'd' - T}{p'} \right] \tag{14}$$

$$\text{s.t.} \qquad \left(\frac{p'_h}{p'}\right)^{-\sigma} y' + \tau \left(\frac{p'_f}{p^*}\right)^{-\sigma} y^* = z {k'}^{\alpha} {n'}^{1-\alpha} \tag{15}$$

$$a' = k' - qd' \tag{16}$$

$$d' \leq \theta k' \tag{17}$$

This optimization includes sales abroad as part of cash on hand, adds foreign demand inclusive of the iceberg cost of exporting in condition (15), and takes into account that an exporter chooses ${p'}_f$ in addition to k', d', ${p'}_h$ and n'. Since the decision to become an exporter is irreversible, $v^E(\cdot)$ is the same function in both sides of (13).

The value of switching to become an exporter, $v^S(m,z)$, solves the following problem:

$$v^S(m,z) = \max_{a'} \Big[u\left(m-(1-\rho)a' - wF\right) + \tilde{\beta} v^E\left(\tilde{m}'(a',z),z\right) \Big] \tag{18}$$

$$\tilde{m}'(a', z) = \max_{k', d', {p'}_h, {p'}_f, n'} \left[\frac{w' + \frac{{p'}_h^{1-\sigma}}{p'^{-\sigma}} y' + \frac{{p'}_f^{1-\sigma}}{p^{*-\sigma}} y^* - w'n' + p'(1-\delta)k' - p'd' - T}{p'} \right] \tag{19}$$

$$\text{s.t.} \qquad \left(\frac{p'_h}{p'}\right)^{-\sigma} y' + \tau \left(\frac{p'_f}{p^*}\right)^{-\sigma} y^* = z{k'}^{\alpha}{n'}^{1-\alpha} \tag{20}$$

$$a' = k' - qd' \tag{21}$$

$$d' \leq \theta k' \tag{22}$$

The value function in the right-hand-side of (18) is that pertaining to an entrepreneur who is already an exporter, $W^E(\cdot)$, which differs from $v^E(\cdot)$ because of the entry cost of becoming an exporter that is incurred only in the first period when the entrepreneur makes the switch. Notice that m includes prices, factor demands, and production of date t chosen while still not being able to export, while $\tilde{m}'(\cdot)$ is chosen including optimal choices to start exporting as of $t+1$. This captures the assumption that it takes one period after making the decision to switch for a firm to be able to start selling abroad.

We verify in our quantitative application that the value functions are increasing and concave in m for all z, and cross once with $v^S(\cdot)$ crossing $v^{NE}(\cdot)$ from below. Hence, for a given z drawn at birth, there is a threshold value of cash on hand $\hat{m}(z)$ at which the firm switches to become an exporter defined by $v^{NE}(\hat{m}, z) = v^S(\hat{m}, z)$. Hence, the payoff function for an entrepreneur at state (m, z) is given by:

$$V(m, z) = \begin{cases} v(m, z) & \text{for } m \leq \hat{m}(z) \\ v^E(m, z) & \text{for } m > \hat{m}(z) \end{cases} \tag{23}$$

3.3 Recursive stationary equilibrium

We focus on the effects of capital controls on the recursive stationary equilibrium for tractability. Accordingly, and since the model has no risk, we assume $\beta R^* = 1$. This ensures that the steady-state capital of a firm prevented from borrowing at R^* by capital controls is the same as that of a firm in the economy without capital controls. Notice that aggregate prices are stationary, but there is a distribution of entrepreneurs with different productivity, net worth, firm prices and trade status, and that these will change in response to the introduction of capital controls.

For given q (i.e., given r^* and $\hat{r}$), p^* and y^*, the model's recursive stationary equilibrium consists of aggregate prices $\{w, p\}$, final goods output $\{y\}$, entrepreneur decision rules $\{c(\cdot), a'(\cdot), n'(\cdot), \tilde{m}'(\cdot), p_h'(\cdot), p_f'(\cdot), y_h'(\cdot), y_f'(\cdot), d'(\cdot), k'(\cdot), e(\cdot)\}$, lump-sum taxes T, value functions $v(\cdot), v^{NE}(\cdot), v^S(\cdot), v^E(\cdot)$ and a stationary distribution of firms, $\phi(m, z)$, such that:

1. Entrepreneurs' value functions and decision rules solve their optimization problems.
2. Decision rules for demand of intermediate goods and output of final goods solve the final-goods producer's problem.
3. The government budget constraint is satisfied: $p\rho\underline{k} = T$.
4. The labor market clears: $\int [n'(m, z) + F\mathbb{1}_{\tilde{m}'(m,z)=\hat{m}(z)}]d\phi(m, z) = 1$, where $\hat{m}(z)$ is the threshold that defines entrepreneurs switching from non-exporters to exporters.
5. The market of final goods clears: $\int [c'(m, z) + x'(m, z)]d\phi(m, z) + \rho\underline{k} = y$, where $c'(m, z) = \tilde{m}'(m, z) - (1 - \rho)a'(\tilde{m}'(m, z), z)$ and $x'(m, z) = (1 - \rho)k'(\tilde{m}'(m, z), z) - (1 - \delta)k'(m, z)$.
6. $\phi(m, z)$ satisfies the following stationarity condition (i.e., it is a fixed point of the law of motion of conditional distributions of (m, z)):

$$\phi(m', z') = \int\int [(1 - \rho)I^S(m', m, z) + \rho I^D(m', m, z)]\phi(m, z)dmdz, \tag{24}$$

   where $I^S(m', m, z)$ and $I^D(m', m, z)$ are indicator variables for surviving and deceased firms, respectively, such that $I^S(m', m, z) = 1$ if $m' = \tilde{m}'(m, z)$ and $I^D(m', m, z) = 1$ if $m' = \underline{m}(z)$ and zero otherwise.[10] $\underline{m}(z)$ is the cash on hand of a newborn firm, which is given by $\underline{m}(z) = [w + \underline{p}_h(z)z\underline{k}^\alpha n(z)^{1-\alpha} - w\underline{n}(z) + p(1 - \delta)\underline{k} - T]/p$, where $\underline{p}_h(z), \underline{n}(z)$ are the solutions that maximize m taking as given $k = \underline{k}$ and $d = 0$ and subject to the market-clearing constraint for production of y_h.[11] The distribution of $\underline{m}(z)$ is induced by the log-normal distribution of z. Moreover, applying the envelope

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[10] $\tilde{m}'(m, z)$ is set to the corresponding decision rule for non-exporters if $v^{NE}(m, z) > v^S(m, z)$, exporters if $v^S(m, z) > v^{NE}(m, z)$, and switchers if $v^{NE}(m, z) = v^S(m, z)$ (i.e., those at the threshold $\hat{m}(z)$).

[11] At equilibrium, total revenue $p_h y_h + p_f y_f$ can be expressed as $p_h z k^\alpha n^{1-\alpha}$. To derive this result, substitute the demand functions for y_h, y_f, apply the equilibrium condition $p_f = \tau p_h$ and simplify.

theorem to this maximization problem yields $d\underline{m}(z)/dz = \underline{p}_h(z)\underline{k}^{\alpha}\underline{n}(z)^{1-\alpha} > 0$. Hence, $\underline{m}(z)$ rises with z and only via its first-order effect on production. Note also that some newborn entrepreneurs choose to become exporters (i.e., $\underline{e}(z) = 1$). This is the case for those who draw high enough z such that $v^S(\underline{m}(z), z) \geq v^{NE}(\underline{m}(z), z)$, otherwise $\underline{e}(z) = 0$.

3.4 Capital Controls and Misallocation

In this section, we characterize the effects of the model's financial frictions on misallocation. We start by examining the optimality conditions of an entrepreneur's second-stage problem of maximizing $\tilde{m}'$ by choosing d', k', p'_h, p'_f, n' for a given a' (eqs. (14)-(17)). The optimization problems for non-exporters and switchers are very similar (except there are no foreign sales and no price associated with them). The first-order conditions simplify to:

$$MRPN = \frac{p'_h}{\varsigma}(1-\alpha)z(k')^{\alpha}(n')^{-\alpha} = w' \tag{25}$$

$$MRPK = \frac{p'_h}{\varsigma}\alpha z(k')^{\alpha-1}(n')^{1-\alpha} = \mathbb{1}_{d'\leq 0}\left[p'(r^* + \delta) + \mu R^*\right] + \mathbb{1}_{d'>0}\left[p'(\hat{r} + \delta) + \eta(\hat{R} - \theta)\right] \tag{26}$$

$$\left(\frac{p'_h}{p'}\right)^{-\sigma} y + \tau\left(\frac{p'_f}{p^*}\right)^{-\sigma} y^* = zk'^{\alpha}n'^{1-\alpha} \tag{27}$$

$$p'_f = \tau p'_h \tag{28}$$

$$d' = R[k' - a'] \tag{29}$$

where $\varsigma = \sigma/(\sigma-1)$ is the markup of price over marginal cost, η is the multiplier on the collateral constraint ($\eta > 0$ only if $d' > 0$ *and* the collateral constraint binds, otherwise $\eta = 0$), and μ is the multiplier on a no-borrowing constraint that prevents borrowing at the rate R^* because of the capital controls ($\mu > 0$ only if $d' \leq 0$ *and* the no-borrowing constraint binds, otherwise $\mu = 0$).[12] The left-hand-sides of (25) and (26) are the marginal revenue products of labor ($\frac{\partial(p_h y_h + p_f y_f)}{\partial n}$) and capital ($\frac{\partial(p_h y_h + p_f y_f)}{\partial k}$), respectively.[13] When $\eta > 0$, k' is set by the collateral constraint at $k'(a') = [\hat{R}/(\hat{R} - \theta)]a'$, and when $\mu > 0$, $k'(a') = a'$.

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[12] The budget constraint with CCs is akin to the textbook problem with a kinked budget constraint. The non-differentiability of the problem due to the kink is circumvented by solving an equivalent problem with the constraint $d' \leq 0$ for $R = R^*$. The multipliers η and μ for maximizing $\tilde{m}'$ are related to those for maximizing lifetime utility in the standard optimization problem, $\tilde{\eta}$ and $\tilde{\mu}$, by the conditions $\eta = \tilde{\eta}\frac{p'}{\beta u'(c')}$ and $\mu = \tilde{\mu}\frac{p'}{\beta u'(c')}$.

[13] See Appendix D for the corresponding derivations.

Three important properties of the above conditions: First, the collateral constraint and the constraint that rules out borrowing at R^* because of capital controls can never bind at the same time. A firm that is borrowing with the collateral constraint binding borrows at $\hat{R}$, hence $\eta > 0$ and $\mu = 0$. A firm that is not borrowing because it would like to borrow at R^* but not at $\hat{R}$ has $\eta = 0$ and $\mu > 0$. Second, the optimal choices of k' and n' (as well as p'_h and p'_f) only depend on a' if either $\eta > 0$ or $\mu > 0$. Otherwise Fisherian separation holds, because the optimal k' is independent of a' and d'. Third, there is no labor misallocation in the model, even when the financial distortions are present (in the sense that the MRPN of all firms is the same and it equals the wage rate they all pay).

3.4.1 No financial distortions

Consider, as a benchmark, factor allocations in the absence of financial distortions. Hence, assume $\theta \to \infty$, to ensure that the collateral constraint never binds and $\nu = 0$, so CCs are not present.[14] In this case, the MRPs of capital and labor are equalized across firms in the decentralized equilibrium. Moreover, a utilitarian planner without financial frictions sets allocations in the same manner. These results are contained in the following propositions:

Proposition 1. *If $\theta \to \infty$ and $\nu = 0$ (no collateral constraint and no CCs), all firms equate factor prices to their corresponding marginal revenue products.*

Proof. If $\theta \to \infty$ and $\nu = 0$, the first-order conditions (25) and (26) reduce to:

$$MRPN_i = w \quad \text{and} \quad MRPK_i = p(r^* + \delta).$$

$\square$

Despite the fact that firms differ in their productivity z_i, at equilibrium they have the same MRPK and the same MRPN because they face the same aggregate prices w, r^*, p.

Proposition 2. *The efficient allocations of a utilitarian planner free of financial frictions imply constant marginal revenue products of capital and labor across firms.*

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[14] $\theta \to \infty$ is sufficient but not necessary for the collateral constraint to be irrelevant. The necessary condition is $\theta > R^*[1 - (\underline{k}/\bar{k})]$, where $\bar{k}$ is the steady-state capital of the firm without financial distorions. Intuitively, with this value of θ even the newborn entrepreneurs who receive $\underline{k}$ can borrow what they need to attain $\bar{k}$.

Proof. See Appendix F. □

The marginal revenue products of capital and labor are equal between firms both in the decentralized and the socially optimal equilibria, and there is no misallocation, in the sense that no factor reallocation across firms would be optimal.[15]

3.4.2 Financial distortions and Misallocation

The presence of financial distortions, either collateral constraints or CCs, implies that MRPKs are not equalized across firms, particularly for firms with capital lower than their optimal scale (i.e., their steady-state $\bar{k}_i$). We consider first a case in which CCs are present but there are no collateral constraints and then a case with the opposite features.

Proposition 3. *When $\theta \to \infty$ and $\nu > 0$ (no collateral constraint with CCs), $MRPK_i > \overline{MRPK} = p(r^* + \delta)$ if $k_i < \bar{k}_i$.*

Proof. If $\theta \to \infty$ and $\nu > 0$, the first-order conditions of entrepreneur i's problem with respect to labor and capital are, respectively,

$$MRPN_i = w, \text{and}$$

$$MRPK_i = \mathbb{1}_{d_i>0}[p(\hat{r} + \delta)] + \mathbb{1}_{d_i\leq 0}\left[p(r^* + \delta) + R^*\mu_i\right],$$

Firms with capital below $\bar{k}_i$ borrow at the interest rate $\hat{r}$ to invest and are subject to the CC, so they have $MRPK_i = p(\hat{r} + \delta) > \overline{MRPK}$. All firms in this category jump to a pseudo-steady state with a capital stock $\bar{k}_i^{CC}$ that differs across them only because of their z_i. Fisherian separation holds and they share a common MRPK equal to $p(\hat{r} + \delta)$. Since $\beta(1 + \hat{r}) > 1$, however, these firms will find it optimal to gradually reduce their debt and increase their net worth until they reach a point in which $d_i = 0$. From then onwards, the interest rate that applies to them becomes r^*. They would like to borrow to jump to $\bar{k}_i$ but they cannot because there is no borrowing at R^*, so they start accumulating capital gradually, effectively as if they were under financial autarky.[16] As long as $k_i < \bar{k}_i$, $MRPK_i = [p(r^* + \delta) + R^*\mu_i] > \overline{MRPK}$

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[15] As it is standard in monopolistic competition settings, the first-best allocations yield higher production than the decentralized equilibrium ones because imperfect substitutability between varieties implies that firms have market power to set prices in the latter case. Hence, we can constrain the planner to use the same aggregate capital and labor as in the decentralized equilibrium to obtain the same allocations in both problems.

[16] At equilibrium, $u'(c_i)/\beta u'(c_i') = (MRPK_i/p') + 1 - \delta$ for these firms (see section 3.4.3).

because $\mu_i > 0$. Moreover, in this case, the MRPK's differ also across firms in this category, with those more distant from $\bar{k}_i$ having higher MRPK. $\square$

CCs distort the allocation of capital via two effects. First, there is an effect common to all firms because they pay the same tax rate when borrowing from abroad, which increases the opportunity cost of funds by the same amount to all firms in a way akin to the efficiency wedge of debt taxes in representative agent models. Second, there is also an effect due to heterogeneity in the financial conditions of firms that representative agent models miss: μ_i is larger for firms that are more debt constrained (i.e., firms with lower a' that would have liked to borrow at R^* but not at $\hat{R}$).

Consider next the case of an economy with collateral constraints but without CCs:

Proposition 4. *For θ sufficiently low so that constraint* (6) *binds for some entrepreneurs and $\nu = 0$ (collateral constraint without CCs), $MRPK_i > \overline{MRPK} = p(r^* + \delta)$ if $k_i < \bar{k}_i$.*

Proof. If $\theta < \infty$ and small enough so that constraint (6) binds, the first-order conditions are:

$$MRPN_i = w, \text{and}$$

$$MRPK_i = p(r^* + \delta) + \eta_i(R^* - \theta),$$

Firms with $k_i < \bar{k}_i$ borrow to invest. Without the collateral constraint, they would jump to $\bar{k}_i$, but the collateral constraint makes this unfeasible. Instead, they must set investment so that $k'_i(a'_i) = [R^*/(R^* - \theta)]a'_i$. Capital accumulation occurs gradually, again in a manner akin to financial autarky, and the constraint binds as long as $k_i < \bar{k}_i$, so $\eta_i > 0$ and thus $MRPK_i > \overline{MRPK}$.[17] $\square$

In this case, MRPK equals $p(r^* + \delta)$ plus the marginal cost of capital associated with the tightness of the credit constraint. This last cost is given by the shadow value of the constraint η_i, which is in terms of marginal utility, multiplied by the opportunity cost of capital net of the benefit that an additional unit of capital provides as pledgeable collateral, which relaxes the collateral constraint by the fraction θ. As with CCs, the collateral constraint generates misallocation through dispersion in the MRPK of firms that have not reached their

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[17] At equilibrium, $u'(c_i)/\beta u'(c'_i) = [R^*/(R^* - \theta)][(MRPK_i/p') + 1 - \delta - \theta]$ for these firms (see section 3.4.3).

optimal scale. The MRPK of credit-constrained firms differs from that of firms that are at the optimal scale and also across the constrained firms themselves, with higher MRPKs for those that are more constrained.

3.4.3 Comparing regimes: "static" effects

Our main goal is to compare a regime with credit constraints and no capital controls (NCC regime) with one in which both credit constraints and capital controls are present (CC regime). We start by comparing the outcome of the second-stage ("static") optimization problems of entrepreneurs. Conditions (25)-(29) and Propositions 3 and 4 provide helpful input.

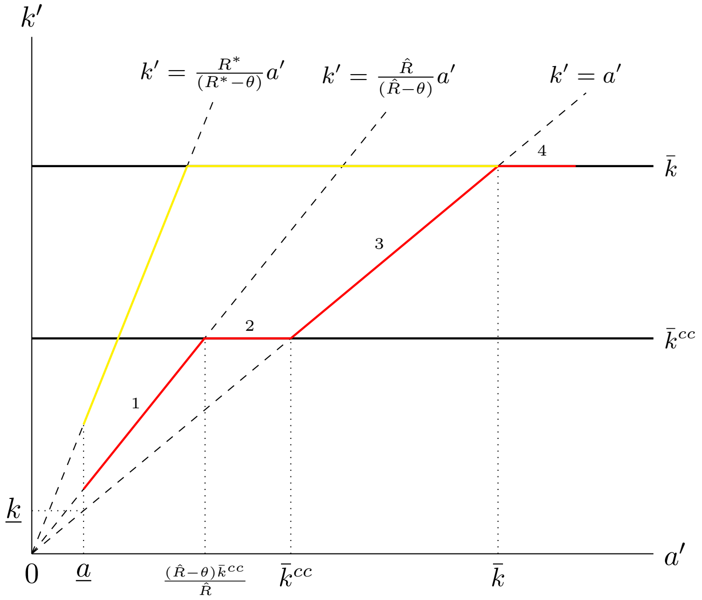
Figure 1 plots an entrepreneur's choice of k' for given a' in both regimes in the interval $a' \in [\underline{k}, \bar{k}]$ (for a given value of z and keeping (y, p, w) constant). The two horizontal lines correspond to $\bar{k}$ and $\bar{k}^{cc}$. The 45° ray corresponds to $k' = a'$, which is the capital choice when the capital controls prevent borrowing at R^*. The rays with slopes of $R^*/(R^* - \theta) > \hat{R}/(\hat{R} - \theta) > 1$ indicate the choices of k' consistent with the collateral constraint when the interest rate is R^* and $\hat{R}$, respectively. The red and yellow piece-wise linear functions show the choice of k' in the CC and NCC regimes, respectively.

Conditions (25)-(29) imply that the choice of k' in the CC regime can be broken down into the four regions labeled in the Figure:

1. For $a' \in [\underline{k}, ((\hat{R}-\theta)/\hat{R})\bar{k}^{CC}]$, the outcome is analogous to Proposition 4, but substituting R^* for $\hat{R}$ and $\bar{k}^{CC}$ for $\bar{k}$. The firm would like to borrow at $\hat{R}$ to jump to $\bar{k}^{CC}$ but is credit constrained, so it can only attain $k'(a') = [\hat{R}/(\hat{R}-\theta)]a'$. As Proposition 4 showed, firms in this category have higher MRPK the further away they are from $\bar{k}^{CC}$. MRPKs differ across these firms and they all differ from $\overline{MRPK}$. As we show later, these firms have stronger incentives to save because they face a higher endogenous effective interest rate given by $\hat{R}\,[1 + (\eta/p')]$. Thus, they increase a' and k' gradually until they reach $\bar{k}^{CC}$.

2. For $a' \in (((\hat{R} - \theta)/\hat{R})\bar{k}^{CC}, \bar{k}^{CC}]$, the outcome is also related to Proposition 4. These firms have attained the pseudo-steady state consistent with $\hat{R}$, and since $\beta\hat{R} > 1$, they also have incentives to save and thus gradually pay down their debt to zero. MRPK is the same for all of firms in this category, but since $\hat{R} > R^*$, it exceeds $\overline{MRPK}$.

Figure 1: Optimal k' as a function of a'.



3. For $a' \in [\bar{k}^{CC}, \bar{k})$, the outcome is analogous to Proposition 3. The firm has no debt, so it faces the interest rate R^*. It would like to borrow to jump to $\bar{k}$ but it cannot at this rate because of CCs. Hence it chooses $k' = a'$. MRPKs differ across firms in this category and they are higher for the more debt-constrained, and they all exceed $\overline{MRPK}$. Similar to region 1, these firms have stronger incentives to save because of a higher endogenous effective interest rate given by $R^* \left[1 + (\mu/p')\right]$. Thus, a' and k' rise gradually until reaching $\bar{k}$ while maintaining $d' = 0$.

4. For $a' \geq \bar{k}$, the firm has attained its optimal scale. It does not need to borrow, and hence neither the collateral constraint nor the capital controls affects it. Any firm with $a' > \bar{k}$ would have a positive position in foreign bonds, instead of debt, given by $d' = R^*[\bar{k} - a'] < 0$. As Proposition 3 shows, these firms have the same MRPK and it is equal to $\overline{MRPK}$.

For the model's numerical solution, it is important that in each of these regions the system (25)-(29) has closed-form solutions for (k', d', p'_h, p'_f, n') given $(a', z; y', p', w')$ that do not depend on consumption. Hence, $\tilde{m}'(\cdot)$ is well defined.

The above discussion indicates that the model features three *static effects* causing misallocation (i.e., channels working through the entrepreneurs' second-stage problem of maximizing cash on hand): 1) binding collateral constraints at higher borrowing costs (region 1); 2) CCs increasing borrowing costs even for firms not affected by the collateral constraint (region 2); 3) CCs preventing firms to borrow at the rate R^* (region 3).

This analysis is incomplete, however, because by taking a' as given it ignores *dynamic effects* resulting from differences in the net-worth decision rule that solves the entrepreneurs' first-stage optimization problem, $a'(m, z)$, across the CC and NCC regimes. A firm with the same m and z makes different net worth choices in the two regimes that imply different locations along the horizontal axis of Figure 1 and therefore different $k'(a'(m, z))$ decisions. In addition, the different net-worth decision rules result in different stationary distributions of firms across the two regimes. There are also *general equilibrium (GE) effects*, because the solutions produced by the system (25)-(29) depend on the aggregate variables (y', p', w'), which differ across regimes. Even for firms in group 4., MRPKs in the CC regime differ from the value of $p(r^* + \delta)$ corresponding to either the NCC regime or the economy without financial distortions. MRPNs also differ, since w is also different. Hence, GE effects alter both the optimal scale of firms and the stringency of the credit constraints they face. We discuss further these GE and dynamic effects later in this Section.

Figure 1 shows that, for a given (a', z) and keeping (y, p, w) the same (i.e., abstracting from GE and dynamic effects), k' is (weakly) larger in the NCC case than in the CC case. Except for firms that have attained their optimal scale (region 4), firms with the same a' always choose a larger k' in the NCC regime. In region 1, the collateral constraint supports a higher capital stock with R^* than with $\hat{R}$. In region 2, firms in the CC regime are at the pseudo-steady state $\bar{k}^{cc}$, and $R^* > \hat{R}$ implies that $\bar{k} > \bar{k}^{cc}$. In region 3, firms in the CC regime hit the no-borrowing constraint and set $k' = a'$, which is less than their optimal scale $\bar{k}$, while firms in the NCC regime are already at $\bar{k}$.

The different k' choices translate into different MRPKs across the two regimes. To characterize the difference, consider that the solutions to (25)-(29) imply three conditions that relate a firm's capital to its price, its capital-output ratio and its MRPK:

$$p'_h(a') = \left[\frac{[(p')^{\sigma} y' + (p^*)^{\sigma} \tau^{1-\sigma} y^*]^{\alpha}}{z\, (k'(a', z))^{\alpha} \left[\frac{1-\alpha}{w'\varsigma}\right]^{1-\alpha}} \right]^{\frac{1}{1+\alpha(\sigma-1)}} \tag{30}$$

$$\frac{k'}{n'}\left(a'\right) = \left[\frac{w'\varsigma}{(1-\alpha)zp'_h(a',z)}\right]^{1/\alpha} \tag{31}$$

$$MRPK(a') = \frac{\alpha z}{\varsigma}\frac{p'_h(a',z)}{\left[\frac{k'}{n'}\left(a',z\right)\right]^{1-\alpha}} \tag{32}$$

For given $(a', z; y', p', w')$, the fact that the CC regime has lower $k'(a')$ implies that the firm charges a higher price and has a lower capital-output ratio, and these two effects increase the firm's $MRPK$. Thus, MRPK is higher in the CC case than in the NCC case for all firms below their optimal scale that have the same (a', z) (and again ignoring GE and dynamic effects). Moreover, since $\delta p'_h(a')/\delta a' < 0$ implies that $\delta \frac{k'}{n'}\left(a'\right)/\delta a' > 0$, $MRPK(a')$ is non-increasing in a' in both regimes. Thus, as a' increases, misallocation falls continuously in the NCC regime until it vanishes when firms reach their optimal scale. In contrast, in the CC regime, MRPK falls with a' in region 1 (but is always higher than in the NCC regime, since $k(a')$ is smaller), then is constant as a' rises in region 2 (since in this region $k(a')$ is independent of a'), and then decreases again in region 3 until it vanishes (since this region is akin to region 1. but with $\theta = 0$).

Using condition (32), the difference in MRPKs ($\Delta MRPK(a') \equiv MRPK_{CC}(a') - MRPK_{NCC}(a')$) across regimes for a common a' is:

$$\Delta MRPK(a') = \frac{\alpha z}{\varsigma}\left[\frac{p'_{h,CC}(a')}{\left[\frac{k'}{n'}_{CC}\left(a'\right)\right]^{1-\alpha}} - \frac{p'_{h,NCC}(a')}{\left[\frac{k'}{n'}_{NCC}\left(a'\right)\right]^{1-\alpha}}\right] \geq 0, \tag{33}$$

which equals zero only in region 4. $\Delta MRPK(a')$ is itself non-increasing in a' since the difference in capital choices across the two regimes is non-increasing in a'. Hence, the firms with the lowest a' will display the highest misallocation, at each level of z.

The above is a characterization of MRPKs in physical terms. We can use the right-hand-side of condition (26) to express $\Delta MRPK$ in financial terms. In regions 1 and 2, where firms are borrowing and the collateral constraint may bind in one or both regimes:

$$\Delta MRPK|_{d'_{CC}>0} = \left(p'_{CC} - p'_{NCC}\right)(r^* + \delta) + \nu p'_{CC}\left(1 + \frac{\tilde{\eta}_{CC}}{\tilde{\beta} u'(c'_{CC})}\right) + \left(\frac{p'_{CC}\tilde{\eta}_{CC}}{\tilde{\beta} u'(c'_{CC})} - \frac{p'_{NCC}\tilde{\eta}_{NCC}}{\tilde{\beta} u'(c'_{NCC})}\right)(R^* - \theta), \tag{34}$$

where we used the condition $\eta = p' \frac{\tilde{\eta}}{\tilde{\beta} u'(c')}$ to replace η, the multiplier of the collateral constraint when maximizing m, with its equivalent in terms of the multiplier of the constraint when maximizing lifetime utility ($\tilde{\eta}$). When the constraint tighthens, $\frac{\tilde{\eta}}{\tilde{\beta} u'(c')}$ rises because $\tilde{\eta}$ increases and, since the credit constraint forces consumption into the future, $u'(c')$ falls.

Evaluating the avove expression abstracting from GE and dynamic effects yields $\Delta MRPK|_{d'_{CC}>0} = \nu(p' + \frac{\tilde{\eta}_{CC}}{\tilde{\beta} u'(c'_{CC})}) + (p'/\tilde{\beta}) \left(\frac{\tilde{\eta}_{CC}}{u'(c'_{CC})} - \frac{\tilde{\eta}_{NCC}}{u'(c'_{NCC})} \right) (R^* - \theta) > 0$, which must be positive as implied by (33). Hence, the differences in p_h and k/n that explain higher MRPKS for a given a' in the CC regime in regions 1 and 2 are due to (a) the higher borrowing cost ν affecting all firms equally (the term $\nu p'$) and more those that are more constrained (the term $\nu \frac{\tilde{\beta} \tilde{\eta}_{CC}}{u'(c'_{CC})}$) and (b) if the collateral constraint is binding, firm-specific differences in the tightness of this constraint across regimes $\left(\frac{\tilde{\eta}_{CC}}{u'(c'_{CC})} - \frac{\tilde{\eta}_{NCC}}{u'(c'_{NCC})} \right) > 0$, which is positive because, for a given a', the constraint always binds more in the CC regime.[18]

In region 3, where firms hit the no-borrowing constraint in the CC regime and the collateral constraint may or may not bind in the NCC regime:

$$\Delta MRPK|_{d'_{CC} \leq 0} = \left(p'_{CC} - p'_{NCC} \right) (r^* + \delta) + R^* \left(\frac{p'_{CC} \tilde{\mu}_{CC}}{\tilde{\beta} u'(c'_{CC})} - \frac{p'_{NCC} \tilde{\eta}_{NCC}}{\tilde{\beta} u'(c'_{NCC})} \right) + \theta \frac{p'_{NCC} \tilde{\eta}_{NCC}}{\tilde{\beta} u'(c'_{NCC})}, \tag{35}$$

where we made the same substitution for η as above and we also used the condition $\mu = p' \frac{\tilde{\mu}}{\tilde{\beta} u'(c')}$ to replace μ, the multiplier of the no-borrowing constraint when maximizing m, with its equivalent in terms of the multiplier of the same constraint when maximizing lifetime utility ($\tilde{\mu}$). When this constraint tightens, $\frac{\tilde{\mu}}{\tilde{\beta} u'(c')}$ rises for the same reason as $\frac{\tilde{\eta}}{\tilde{\beta} u'(c')}$.

Ignoring GE and dynamic effects, and if firms in the NCC regime are already at their optimal scale (as in the example of Figure 1), the above expression reduces to $\Delta MRPK|_{d'_{CC} \leq 0} = R^* \frac{p' \tilde{\mu}_{CC}}{\tilde{\beta} u'(c'_{CC})} > 0$, with more constrained firms showing larger MRPK differences across regimes. If the collateral constraint binds in the NCC regime, the difference in MRPKs depends also on how much tighter is the no-borrowing constraint in the CC regime than the collateral constraint in the NCC regime.[19]

This analysis also suggests that a tighter credit constraint (i.e., lowering θ) may gen-

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[18] For a common (a', z), the constraint allows for more debt in the NCC regime since $R^*/(R^* - \theta) > \hat{R}/(\hat{R} - \theta)$.

[19] $\mu_{CC} > \eta_{NCC}$ because, for a common (a', z) in region 3, if firms in the NCC regime are constrained, the collateral constraint with R^* allows for more debt than the no-borrowing constraint in the CC regime.

erate less misallocation than the CCs. Intuitively, in Figure 1, one can think of the ray where the constraint binds in the CC regime as one without CCs but a lower θ. Misallocation would decrease continuously as a' rises until firms reach their optimal scale. Misallocation would be the same as in the case with CCs in region 1, but lower in regions 2 and 3.

Whether firms are exporters or not matters for these results. Non-exporters do not have the effect of foreign demand on p'_h observed in condition (30). This effect increases the exporters' prices and reduces their capital-output ratios, which together result in higher MRPKs. Thus, exporters will have higher MRPKs than non-exporters when they are credit constrained (in either region 1 or region 3).

3.4.4 Dynamic effects, general equilibrium effects and welfare measures

We shed some light on the dynamic effects of the model's financial distortions by examining the entrepreneurs' optimal consumption and saving plans. Applying the envelope theorem to the first-stage optimization problem of exporters (problem (18)) yields this Euler equation:

$$u'(c) = \beta u'(c') \frac{\delta \tilde{m}'(a', z; y', p', w')}{\delta a'} \tag{36}$$

Differentiating condition (19) and simplifying using conditions (25)-(26), we find that:

$$\frac{d\tilde{m}'(a', z; y', p', w')}{da'} = \mathbb{1}_{d'>0} \left[\hat{R} \left(1 + \frac{\eta}{p'} \right) \right] + \mathbb{1}_{d' \leq 0} \left[R^* \left(1 + \frac{\mu}{p'} \right) \right], \tag{37}$$

with the caveat that this derivative is not defined at the kinks where the $k'(a')$ function changes regions, since $k'(a')$ is piece-wise linear and changes slope at the kinks.

It follows from the above two results that in regions 2 and 4, $u'(c)/\beta u'(c') = R$ where R equals $\hat{R}$ and R^*, respectively. Thus, region 4 yields the familiar result from small open economy models without financial frictions: Entrepreneurs that have reached their optimal scale are unaffected by CCs and collateral constraints and make optimal saving plans so as to equate their intertemporal marginal rate of substitution (IMRS) in consumption with the world's real interest rate R^*. Since $\beta R^* = 1$, these entrepreneurs desire consumption to be stationary. Something similar occurs in region 2, for firms that borrow at the rate $\hat{R}$ unaffected by the collateral constraint, except that the real interest rate is higher because of the capital controls. Since $\beta\hat{R} > 1$, these entrepreneurs are at the pseudo-steady state of capital but still desire to reallocate consumption into the future by saving.

In region 1, for entrepreneurs that borrow at $\hat{R}$ but are credit constrained, we obtain:

$$\frac{u'(c)}{\beta u'(c')} = \hat{R}\left[1 + \frac{\eta}{p'}\right] = \frac{\hat{R}}{\hat{R} - \theta}\left[\frac{MRPK'}{p'} + 1 - \delta - \theta\right] \tag{38}$$

and in region 3, for entrepreneurs that hit the no-borrowing constraint at R^*, we obtain:

$$\frac{u'(c)}{\beta u'(c')} = R^*\left[1 + \frac{\mu}{p'}\right] = \left[\frac{MRPK'}{p'} + 1 - \delta\right]. \tag{39}$$

These two cases are analogous in that (a) the financial distortions increase the effective real interest rate faced by the entrepreneurs and (b) the IMRS and the net marginal return on capital accumulation are equalized as if entrepreneurs were in financial autarky, so that there is no Fisherian separation between the consumption/saving choice and the investment choice.

These findings imply that CCs have differential effects across entrepreneurs in the CC regime relative to the NCC regime. For entrepreneurs in region 1, CCs tighten the collateral constraint, increasing both the contractual borrowing rate from R^* to $\hat{R}$ and the effective interest rate inclusive of the shadow value of the constraint. In this region, the higher interest rate reduces the ability to leverage net-worth to invest in physical capital and at the same time it reduces the incentive to borrow overall, because $\hat{R}$ represents a higher intertemporal relative price of consumption. For those in region 2, only the latter effect is present. For those in region 3, the CCs imply they have yet to reach their optimal scale and they hit the no-borrowing constraint that increases the borrowing rate from R^* to a higher effective rate inclusive of the shadow value of the constraint. Hence, firms in this region are affected by the inability to leverage investment on net-worth but the intertemporal relative price of consumption is R^*. Finally, entrepreneurs in region 4 are unaffected.

The saving distortions have important dynamic implications that also differ across regimes. Because $\beta R^* = 1$, region 4 yields $IMRS = R^*$ and $u'(c) = u'(c')$, so that there is no incentive to save or disave. In contrast, in all other regions $IMRS > R^*$ so entrepreneurs have the incentive to reallocate consumption into the future by saving (increasing a'). As eqs. (38)-(39) show, this effect is stronger for entrepreneurs borrowing at $\hat{R}$ but affected by the collateral constraint and more for those who are more constrained (for these entrepreneurs, $IMRS_i = \hat{R}\left(1+\frac{\eta_i}{p'}\right) > \hat{R}$), followed by those who borrow at $\hat{R}$ but are unconstrained (with $IMRS_i = \hat{R} > R^*$) and then those prevented from borrowing at R^* by the CCs (with $IMRS_i = R^*\left(1+\frac{\mu_i}{p'}\right) > R^*$). Thus, even tough the "static" effects of misallocation summarized in Figure 1 predict lower $k'(a')$ and higher $MRPK(a')$ in the CC than the NCC regime for a common a', this pattern of saving distortions incentivizes higher saving and faster adjustment to the optimal scale (higher decision rules $a'(m,z)$) for firms facing tighter financial constraints and higher interest rates, and this pattern differs across regimes. Hence, in principle, it is possible that an entrepreneur with some (m,z) would save sufficiently more under capital controls (i.e., $a'^{CC}(m,z) > a'^{NCC}(m,z)$) so that eqs. (30)-(32) would predict that MRPK is higher *without* CCs.

These dynamics effects operating via differences in net-worth decision rules across regimes are central to our welfare analysis, because the extent to which misallocation caused by CCs affects the lifetime utility of entrepreneurs is determined by how these differential effects of CCs on saving choices affect consumption plans. Notice that the financial frictions cause inefficiencies both in the investment/capital allocations (causing the misallocation reflected in MRPKs) and in the saving plans (by distorting the intertemporal relative price of consumption due to post-tax and effective interest rates higher than R^*).

It is worth noting that even tough the model lacks a domestic credit market and the interest rates $\hat{R}$ and R^* are exogenous, the effective interest rates faced by credit-constrained entrepreneurs in regions 1 and 3 are endogenous (they depend on η and μ, see eqs. (38)-(39)) and they vary with their corresponding MRPKs. This is akin to a model in which each firm faces an endogenous interest rate determined by its MRPK, and the resulting set of interest rates decentralizes an outcome where lenders do not impose credit constraints but instead tailor the interest rate at which each firm borrows so as to satisfy the credit constraints.

The GE effects of CCs operating via changes in y, p, w and the dynamic effects are difficult to characterize in analytic form. Intuitively, they interact with the static effects to determine the differences across the stationary equilibria of the CC and NCC regimes. Regarding GE effects, the interaction with the static effects works via the effect shown earlier that firms in the CC regime set higher prices for the input they sell, which exerts pressure for p to be higher simply as an implication of the CES price index. On the other hand, higher input prices reduce demand for these inputs by the producer of final goods, putting downward pressure on w, p and y. The share of firms that are exporting also matters, since foreign sales exert pressure for them to post higher prices and they face a weaker demand response to their price increases (y^* is assumed to be independent of the variation in the price of inputs domestic firms sell abroad).

The GE effects on misallocation will be reflected in $\Delta MRPK$ and hence in our welfare measures. Conditions (34)-(35) show that there is a first-order effect of changes in p that induces differences in the efficient level of MRPK in each regime. If $p_{NCC} > p_{CC}$, as will be the case in our calibrated model, this GE effect will push for *lower* misallocation in the CC regime. There are also second-order effects, because differences in (y, p, w) matter for the tightness of the credit constraints that determine $\Delta MRPK$.

The interaction with the dynamic effects works through differences in net-worth decision rules across CC and NCC regimes and in the stationary distributions of firms that they induce ($\phi^{CC}(m, z)$ and $\phi^{NCC}(m, z)$, respectively). These distributions are key for determining aggregate demand in the labor and final-goods markets and hence for determining aggregate prices. Moreover, although the combined effect of the static and GE effects of CCs for a given a' is fully determined by evaluating conditions (30)-(32) using equilibrium prices and allocations, the overall changes on prices, allocations, MRPKs and social welfare across the CC and NCC regimes depend on differences in decision rules and in the distributions $\phi^{CC}(\cdot)$ and $\phi^{NCC}(\cdot)$. In particular, these distributions provide the welfare weights for the utilitarian social welfare function we assume. A particular pattern of differences in MRPKs at equilibrium, determined by evaluating $\Delta MRPK(a')$ using the equilibrium decision rules $a'^{CC}(m, z)$ and $a'^{NCC}(m, z)$, for the CC and NCC regimes respectively, yields a particular welfare effect depending on how firms with higher vs. lower MRPK are weighted.

We study welfare effects using a standard welfare measure based on *individual* (percent) compensating variations in consumption ($g(m, z)$) that make each entrepreneur as well off in the stationary equilibrium under the NCC regime as in the CC regime:[20]

$$g(m,z) = \left(\frac{V^{CC}(m,z;\bar{y}^{CC},\bar{p}^{CC},\bar{w}^{CC})}{V^{NCC}(m,z;\bar{y}^{NCC},\bar{p}^{NCC},\bar{w}^{NCC})} \right)^{\frac{1}{1-\gamma}} - 1, \tag{40}$$

where $\bar{y}^i, \bar{p}^i$ and $\bar{w}^i$, for $i = CC, NCC$, denote the steady-state values of the aggregate variables in each regime. We then measure an *aggregate utility* effect by averaging using $\phi(m,z)$:

$$\bar{g}^i = \int g(m,z) d\phi^i(m,z) \tag{41}$$

where $i = CC, NCC$. Hence, $\bar{g}^{CC}$ ($\bar{g}^{NCC}$) uses $\phi^{CC}(m,z)$ ($\phi^{NCC}(m,z)$) as weights and thus aggregates the individual welfare gains according to the stationary distribution of the CC (NCC) regime. We also compute the *social welfare* effect by adopting a utilitarian social welfare function (SWF), which uses $\phi(m,z)$ as weights, and calculating a compensating consumption variation that equalizes social welfare across the two regimes:

$$G^i = \left[\frac{\int V^{CC}(m,z) d\phi^i(m,z)}{\int V^{NCC}(m,z) d\phi^i(m,z)} \right]^{\frac{1}{1-\gamma}} - 1, \tag{42}$$

where $i = CC, NCC$. These measures use the same weights to evaluate social welfare in the NCC and CC regimes. We also construct a third social welfare measure that uses the stationary distribution of each regime to evaluate the corresponding social welfare:

$$G = \left[\frac{\int V^{CC}(m,z) d\phi^{CC}(m,z)}{\int V^{NCC}(m,z) d\phi^{NCC}(m,z)} \right]^{\frac{1}{1-\gamma}} - 1. \tag{43}$$

Note that $\bar{g}^i$ and G^i isolate the welfare measures from the first-order effect of changes in the stationary distribution of firms across regimes, while G includes this effect.[21] Also, all of these measures compare only stationary equilibria, they do not include the transitional dynamics from the NCC regime to the CC regime.

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[20] Given the definition of m, we can define $m(a,z;\bar{y},\bar{p},\bar{w}) = [\bar{w} + \frac{p_h(a)^{1-\sigma}}{\bar{p}^{-\sigma}}\bar{y} + e\frac{p_f(a)^{1-\sigma}}{p^{*-\sigma}}y^* - \bar{w}n + \bar{p}(1-\delta)k(a) - \bar{p}d(a) - T]/\bar{p}$ as the cash on hand in the stationary equilibrium for an entrepreneur with the values of k, d, p_h, p_f, n set by the corresponding decision rules that are functions of the individual variables (a,z) and of the aggregate variables set at their steady-state values $(\bar{y},\bar{p},\bar{w})$. The exception are newborn entrepreneurs, who have $k = a = \underline{k}$ and $d = 0$ set by initial conditions but still choose p_h, p_f, n optimally by using conditions (25), (27) and (28) taking as given $k = \underline{k}$.

[21] Second-order effects of changes in $\phi(\cdot)$ are still present because aggregate demand for labor and final goods, and therefore y, p and w, respond as $\phi(\cdot)$ changes.

The social welfare measures can be further decomposed into aggregate and distributional components (G^a and G^d, respectively), following Domeij and Heathcote (2004). Define the share of consumption of a given entrepreneur in the NCC regime as $cs^{NCC}(m, z) \equiv c^{NCC}(m, z)/C^{NCC}$, then construct the distribution-adjusted payoff for the CC regime as:

$$\hat{V}^{CC}(m, z) = u(cs^{NCC}(m, z)C^{CC}) + \tilde{\beta}\hat{V}^{CC}\left(\tilde{m}'\left(a'^{CC}(m, z), z\right), z\right). \tag{44}$$

This payoff allocates the aggregate consumption of the CC regime across entrepreneurs according to the consumption shares they had in the NCC regime. We can then compute aggregate and distributional components as follows: First, calculate the corresponding aggregate social welfare effects ($G^{a,NCC}$, $G^{a,CC}$, G^a) by replacing $V^{CC}(\cdot)$ with $\hat{V}^{CC}(\cdot)$ in the numerators of (42) and (43). Second, calculate the distributional components ($G^{d,NCC}$, $G^{d,CC}$, G^d) as the values that solve $(1 + G^i) = (1 + G^{a,i})(1 + G^{d,i})$ for $i = \{CC, NCC\}$ and $(1 + G) = (1 + G^a)(1 + G^d)$. Notice that the aggregate social welfare component is not the same as the aggregate utility effect $\bar{g}^i$ and that the misallocation and oversaving caused by the financial distortions affect both the aggregate and distributional social welfare components. In particular, the former responds to the effects of the financial distortions on C^{CC}.

4 Quantitative Analysis

We calibrate the NCC regime to match key features of the Chilean economy during the period 1990-1991, before the introduction of the capital controls. This calibration includes a set of parameters with predetermined values that are widely-used as standard or taken from the related literature and a set of parameters that take values targeted so that the NCC stationary equilibrium matches a set of data moments. Table 1 lists the calibrated parameter values. We then construct the CC regime by introducing the asymmetric tax on capital inflows, solve for the stationary equilibrium, and compute the effects of CCs on misallocation and welfare. To set the value of ν, we estimate the tax-equivalent unremunerated reserve requirement implemented in Chile following the methodology proposed by De Gregorio et al. (2000) applied to a loan maturity of 12 months (see Appendix B). The average for the period 1991-1998 yields $\nu = 0.0198$, which is sizable relative to the calibrated value of r^*.

4.1 Calibration of the NCC regime

The set of parameters assigned predetermined values is $\{\gamma, \beta, \sigma, \delta, \rho, r^*\}$. The coefficient of relative risk aversion and the subjective discount factor are set to standard values of $\gamma = 2$ and $\beta = 0.96$. Hence, $R^* = 1/\beta = 1.04167$. The rate of depreciation $\delta = 0.06$ is taken from Midrigan and Xu (2014). The elasticity of substitution across varieties $\sigma = 4$ is from Leibovici (2021), who also calibrated a model to Chilean data and use this value of σ based on estimates from Simonovska and Waugh (2014). The exit rate of firms is $\rho = 0.08$ which is the average exit rate in the Chilean dataset described below over the 1990-2007 period.

The set of parameter values determined by targeting data moments is $\{\tau, \omega_z, F, \theta, \kappa, \alpha\}$.[22] The data targets are: (1) the share of firms that export (0.18); (2) the average sales of exporters divided by average sales of non-exporters (8.55); (3) the ratio of average sales of five- to one-year-old firms, among new firms that survive for at least five years (1.26); (4) aggregate exports as a fraction of total sales (0.21); (5) aggregate credit as a fraction of value added (0.20; and (6) the aggregate capital stock divided by the wage bill (6.6). These targets are computed using Chile's *Encuesta Nacional Industrial Anual* (ENIA) for the 1990-1991 period, except for aggregate credit that corresponds to the total value of outstanding credit in manufacturing from 2000 to 2007, as reported by the Superintendencia de Bancos e Instituciones Financieras de Chile.[23] For all moments we compute the value for each year and then calcule the 1990-1991 average. We choose the 1990-1991 period because capital controls were implemented only in mid-1991 and, arguably, did not affect the data reported for these years. The calibration is executed using an SMM algorithm with equal weight on each parameter (i.e., minimizing the squared differences of moments in the model from their data targets). The resulting parameter values are $\{\tau = 5.127, \omega_z = 0.435, F = 1.35, \theta = 0.136, \kappa = 0.252, \alpha = 0.354\}$.

Table 2 shows the data target moments and their model counterparts in the stationary equilibrium of the calibrated NCC economy. This table shows that the NCC calibration delivers model moments quite close to the data moments. Moreover, in Andreasen et al. (2020) we show that the model does also a reasonable job at matching sectoral moments that

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[22] For the calibration, we allow $\underline{k}$ to vary with z. The capital injection that a new entrepreneur with productivity draw z receives is a fraction κ of its steady state-capital $\underline{k}(z) = \kappa\bar{k}(z)$. This rules out the possibility that, with a common $\underline{k}$ for all entrepreneurs, those with sufficiently low z could start with $\underline{k} > \bar{k}(z)$. Solving the model with a common $\underline{k}$ did not alter the properties of the stationary equilibrium significantly.

[23] ENIA is available since 1980 but exports data are available starting in 1990. See Section 5 for details.

are not targeted in the calibration, which provides external validation to the framework.

4.2 Positive effects of capital controls

As explained in Section 3.4, misallocation arises in the model only when financial distortions are present. CCs and collateral constraints cause misallocation by themselves and misallocation worsens as these constraints tighten. But when CCs are added to collateral constraints, the net effects that result depend on the interaction of static, dynamic and GE effects. The static effects work unambiguously to worsen misallocation when CCs are introduced but the dynamic and GE effects trigger mechanisms that work in the opposite direction. Hence, quantitative exploration is necessary both for assessing the magnitude of the misallocation resulting from financial distortions and for determining the net effects of introducing capital controls on misallocation and social welfare.

Column (1) of Table 3 shows statistics summarizing the aggregate effects of introducing capital controls in the calibrated economy. The three key aggregate variables driving GE effects fall, with y, p, and w falling 1.7%, 1.4% and 2.6%, respectively. Aggregate investment declines 4.4%, aggregate domestic sales of intermediate goods 3.6% and the share of firms that are exporters 8%. Interestingly, aggregate exports themselves actually increase 2%. Hence, fewer firms are exporting but they are exporting significantly more. This is in part because the decline in prices embodies lower firm prices for both domestic and foreign sales, so the larger exporter firms are able to sell more abroad as they lower their prices.

Table 4 reports results showing how misallocation changes when CCs are introduced. The change in misallocation corresponds to the percent change in the weighted sum of squared residuals (SSR) of MRPK of each firm relative to its efficient level in each regime (i.e., $p(r^* + \delta)$ evaluated with p^{CC} or p^{NCC}, respectively), with the residuals weighted using the stationary distribution of each firm. Considering all firms, misallocation rises by 0.11%.

We then divide firms according to their productivity, by grouping all firms pertaining to the lowest (highest) 50% in the distribution of z and labeling them *Low* z (*High* z). Misallocation rises for high-z firms (0.38%) but falls for low-z firms (-0.79%). Since deviations from efficient MRPK are zero for firms at their optimal scale within the CC and NCC regimes, these results are driven by the static, dynamic and GE effects on deviations from efficient

MRPK for firms below their optimal scale. Examining capital decision rules and MPRKs as functions of a, we find that regions 2 and 3 of the capital decision rules have a wide a interval for high-z firms and in this interval MRPKs are significantly larger in the CC regime. Hence, higher misallocation for these firms is largely driven by the financial distortions of the CCs (i.e., the pseudo-steady state $\bar{k}^{CC}$ when they borrow at $\hat{R}$ and the no-borrowing constraint when they cannot borrow at R^*). Misallocation increases for these firms because they become more financially constrained when CCs are introduced. For low-z firms, however, the interval of a for regions 2 and 3 is narrow and yields *higher* MRPKs in the CC regime, and in region 1 MRPKs are similar in magnitude but *larger* relative to efficient MRPK because the latter is lower in the CC regime (since $p^{CC} < p^{NCC}$). Thus, the static and GE effects contribute to *increase* misallocation for low-z firms, rather than lowering it. The reduction is therefore due to the dynamic effects: stronger saving incentives in the CC regime imply that low-z firms spend sufficiently less time at low levels of capital that yield large MRPKs than in the NCC regime, and hence the SSR of their MRPKs is lower than for high-z firms. These dynamic effects are also at work for high-z firms, but they are more than offset by the wider regions 2 and 3 and larger deviations from efficient MRPK.

Next we divide firms according to whether they are exporting or not. The results are striking in that misallocation worsens sharply for exporters (5.34%) and falls markedly for non-exporters (-1.53%). Thus, the modest aggregate change in misallocation hides very sharp differences across exporters and nonexporters. It is worth noting also that exporters are a subset of the high-z firms. The rationale is similar as for the productivity comparison: Misallocation rises for exporters because they have a wide interval of a in regions 2 and 3 and show sharply higher MRPK in the CC regime. Misallocation rises more than in the productivity breakdown because exporters are even more affected by the more severe financial distortions of the CC regime, since they have higher z within the high-z group. The result for non-exporters again reflects the importance of the dynamic effects: non-exporters spend less time at high levels of MRPK in the CC regime because of their stronger saving incentives. The larger quantitative effects on misallocation for exporters reflects also the argument from the previous Section indicating that exporters have higher MRPKs than non-exporters when they are credit constrained, because exporters have the effect of foreign demand for their product, which rises their MRPK because it increases their prices and reduces their capital-labor ratio (see. eqs.(30)-(31)).

Finally, defining old (young) firms as those that have (have not) reached their optimal scale, misallocation is zero for old firms, since they have zero deviation from efficient MRPK in each regime. Misallocation increases only slightly for young firms.

Table 5 shows results breaking down firms by productivity and trade status and by productivity and age. There are no low-z exporters, and hence exporters with high z and non-exporters with low z show the same changes in misallocation as exporters and low-z firms, respectively, in Table 4. For non-exporters, however, misallocation falls also for those with high z and in fact it declines significantly more than for those with low-z (-2.73% vs. -0.79%). Highly productive non-exporters are the group that shows the largest reduction in misallocation when CCs are introduced. They benefit the most from the dynamic effects because they have larger scales than low-z non-exporters and at the same time they are less financially-dependent than exporters. Regarding the breakdown by age and productivity, again old firms have zero effect by construction, because they are at their efficient MRPK for all z. For young firms, however, we see a similar pattern as in Table 4: misallocation falls for those with low productivity but rises for those with high productivity. The intuition is qualitatively the same. The high-productivity, young firms are more affected by the static and GE effects of the tigther financial distortions under the CC regime, while for low-productivity firms, the dynamic effects inducing higher saving and faster growth in the CC regime dominate.

4.3 Welfare effects of capital controls

Figure 2 shows $g(m, z)$ at the ten levels of z considered, averaged across m. For all firms, $g(\cdot) < 0$, which is to be expected because ν is a debt tax that induces inefficiencies in saving and investment decisions, and the revenue generated by the tax is not rebated to entrepreneurs. In addition, the welfare losses are higher for firms with higher productivity levels. This, again, goes in line with our finding about changes in misallocation: the CCs affect entrepreneurs that are transitioning to their optimal scales and borrow in order to acquire capital. Entrepreneurs with low z have lower optimal scales and, consequently, need to borrow less, so they are naturally less affected by the distortions of CCs on efficient investment choices.

Figure 2 shows also that the welfare losses are not monotonically increasing in z.

This is because of the firms that are at the switching phase and thus incur the one-time entry cost, which are captured in the welfare cost for $z = 6$ in the graph. At higher z, all firms that are exporting have made the switch and do not pay the cost. Hence, there are opposing forces on the welfare cost for these firms: Like all other firms, the cost rises at higher productivity, but those at the switching phase can have an even larger cost than exporters with higher z because of the fixed cost. This interacts with differences in the timing of switching decisions across regimes. Switchers (i.e. firms with $z = 6$) take longer to make the switch under the CC regime, and since these entrepreneurs spend proportionally more periods remaining non-exporters, their welfare loss relative to the NCC regime is larger than for the next productivity level. Note also that firms that are already exporters benefit from the fall in wages and domestic prices (i.e., a real depreciation) associated with the CC. This allows them to increase exports and partially overturn the negative direct effect of the CC.

The last column of Table 4 shows the social welfare losses G^{NCC} for all entrepreneurs and dividing by productivity. The welfare loss for all firms is 2.39%, which is large considering that it is due to a 2-percentage-points hike in the interest rate and yet its size is in the ballpark of estimates of the welfare effects of fully replacing a 40 percent capital income tax with labor or consumption taxes in the United States (see Domeij and Heathcote (2004)). Low-z entrepreneurs, which are all non-exporters, are less affected and suffer a welfare loss of 1.65%. Conversely, high-z firms, which include all exporters and some non-exporters, have losses of 3.52%. As discussed before, exporters need to borrow more to reach their optimal scales, so CCs heavily distort their investment and consumption patterns.

Table 6 shows the decomposition of G^{NCC} into aggregate and distributional components for all firms and for low- and high-z firms. For all firms, the aggregate component is -2.70% and the distributional component is actually a *gain* of 0.33%, because the total loss is larger than the aggregate component. The large aggregate loss is due in part to the fact that the debt tax is akin to a standard capital income tax affecting all firms below their optimal scale in the same way. In this model, however, there also aggregate effects that result from the misallocation and oversaving effects of the financial distorions that affect firms differently. The optimal scale of firms is unaffected by these distortions, but as we documented earlier, output of final goods, investment and consumption fall when CCs are introduced. The aggregate welfare loss reflects therefore the effects of misallocation and oversaving on C^{CC}. The small distributional gain implies that consumption is slightly more equally distributed in the CC regime. Firms that are converging to their optimal scales are the ones adversely affected by the debt tax, with firms that are more financially dependent affected more (e.g., young, more productive or exporting firms). This effect is especially strong for high productivity, exporting firms. Hence, the share of consumption of the relatively poor (rich) entrepreneurs rises (falls). The large distributional welfare effects typical of Bewley models of heterogeneous agents are absent because in our model (as in other misallocation models, e.g., Buera and Moll (2015)) there are no insurance and risk-sharing frictions.

Sorting firms by productivity, we find again that CCs result in aggregate welfare losses that are negative and large, and the distributional components are still small. However, the distributional components are now negative for both high- and low-z firms. Hence, within each group, the CCs cause consumption inequality to increase. In the low-z group, this is driven by the fall in w that impacts entrepreneurs with relatively lower z the most, since wage income is a larger part of their income. For the high-z group, the distributional welfare cost is about half as much as for the low-z group, because of the same force at work in the total of all firms: The firms with relatively higher z within this group have larger optimal scales and are affected more by the financial distortions. Interestingly, the positive G^d for all firms implies that there is redistribution between high- and low-z firms that makes consumption more equally distributed, driven by the fact that high-z firms are also exporters that need to finance the sunk cost of becoming exporters and that need to reach larger optimal scales, and this implies that the burden of the debt tax is heavier for them.

4.4 Sensitivity and counterfactual experiments

We examine next the robustness of our findings and the implications of alternative policy strategies. First, we modify the model to rebate the revenue generated by debt-tax payments as a lump-sum transfer to each entrepreneur, matching what each one paid (to rule out introducing redistribution among entrepreneurs). The per-entrepreneur tax rebate is $(1-\rho)p\nu(k'(m,z)-a'(m,z))/R^*$.

Table 3 shows the effects on the model's aggregate variables and Table 7 shows the effects on misallocation and welfare. The results are qualitatively the same as for the case without transfers and quantitatively the differences are small. Considering all firms, misallocation rises slightly more. This is because the tax rebates go to the more credit-constrained entrepreneurs and thus reduce the tightness of their collateral constraints. As $\eta(m, z)$ falls, the dynamic effect reducing their MRPKs that is driven by the higher effective return on saving weakens, and so the dispersion of MRPKs rises. The social welfare cost for all firms is slightly smaller, because the less severe credit constraints of these entrepreneurs reduce their welfare losses. Welfare costs are also smaller for high- and low-z firms. The quantitative effects are small because in fact debt tax payments are small. Firms in regions 3 and 4 do not pay debt taxes because $d = 0$ for all of them. Each firm in region 1 pays a debt tax for the amount $\nu[(1-\rho)p\hat{q}\theta k(m,z)/R^*]$, where $\theta k(m, z)$ is the debt allowed by the collateral constraint. They pay the largest tax when their debt is $\theta\bar{k}^{cc}$, at the kink connecting regions 1 and 2. Firms in region 2 pay a decreasing fraction of that maximum tax as they pay down their debt until they reach zero debt tax at the kink with region 3. The tax payment at the calibrated parameter values is equivalent to a tax of 0.216% on the value of a firm's capital ($\nu(1-\rho)\hat{q}\theta/R^* = 0.00216$), and since firms in region 1 have little capital and in region 2 are reducing debt, the payments are small.

We study next the implications of two alternative "macroprudential" policies designed to reduce the ratio of aggregate credit to GDP by the same magnitude as the CCs. The goal is to study how the effects of these policies differ from those of the CCs. The first policy experiment, denoted the R-policy case, introduces a symmetric increase in the interest rate (i.e., ν increases both the cost of foreign borrowing and the return on lending abroad). The second experiment implements a reduction in the fraction θ of capital that is pledgeable, which represents tightening of a regulatory loan-to-value (LTV) ratio requirement. Hence, this case is denoted the LTV-policy case.

Table 8 shows the results for the R-policy experiment. The static effects are very different from those in the CC case. The optimal scale of all firms, at all z levels, falls and regions 3 and 4 of Figure 1 disappear, with $\bar{k}^{CC}$ now indicating the optimal capital scale for a symmetric interest rate hike at the same $\hat{R}$ value. This value yields the same amount of debt for each firm that can borrow, since firms in regions 3 and 4 had zero debt. Hence, considering only static effects, the same interest rate hike as in the CC regime would be needed to reduce *gross* debt by the same amount. Net debt is smaller, however, because $\beta\hat{R} > 1$

implies that entrepreneurs would keep on saving (i.e., set $d < 0$) after reaching $\bar{k}^{CC}$. Only region 1 has deviations from the efficient MRPK and those deviations are smaller than in the CCs case, because the efficient MRPK is lower too. The dynamic and GE effects change too, however, and the net result is actually a sharp *increase* in misallocation. The R-policy increases p and reduces x and y, because the supply of all inputs shrinks, increasing their prices (both for domestic and foreign sales) and reducing their demand from the final goods producer. Moreover, consumption demand for final goods rises with the higher return on saving, so p rises due to both lower supply and higher demand. This price effect dominates and misallocation increases 7.53% for all firms. As before, misallocation increases more for high-z firms (7.80%) than for low-z firms (6.61%), as the former are more affected since they invest more. Regarding exporters vs non-exporters, misallocation rises by 19.95% and 5.55%, respectively, because the real exchange rate appreciation impacts exporters substantially.

The social welfare loss rises 35 basis points, to 2.74%, compared with -2.39% in the CC case (both measured relative to the initial NCC regime). Interestingly, welfare falls for low- and high-z firms by similar amounts, while in the CC case the burden of the policy is borne disproportionally by high-productivity firms, which are the ones more affected by capital controls. Thus, relative to the CC case, R-policy worsens both misallocation and social welfare but distributes the social cost of the policy more evenly.

We study now the LTV experiment. Attaining the same 30% decline in the debt-GDP ratio as in the CC case requires setting $\theta = 0.097$ (i.e., the LTV regulation reduces the fraction of pledgeable capital by 4 percentage points). Table 9 shows the effects on misallocation and welfare. In terms of static effects in Figure 1, this experiment is equivalent to rotating clock-wise the ray with slope $R^*/(R^* - \theta)$, making it flatter by reducing θ. For $\tilde{\theta}$ such that $\hat{R}/(\hat{R} - \theta) = R^*/(R^* - \tilde{\theta})$, we would have the same ray along which region 1 is located. Moreover, region 1 widens until reaching $\bar{k}$ and regions 2 and 3 vanish. Misallocation falls because the firms that were in regions 2 and some of 3 in the CC regime now can carry debt meeting the collateral constraint and grow their capital faster. Firms in region 1 have the same debt and the same misallocation. This combination implies, however, that $\tilde{\theta}$ generates more debt than the CC regime, so attaining the same debt reduction as with CCs requires an LTV such that $\theta < \tilde{\theta}$. This would imply reduced debt for firms in region 1 and a smaller increase for those in 2 and 3, so that total debt can match the reduction under the CC regime.

Misallocation rises for firms that were in region 1 and some of 2 but falls for those that were in region 3.

The dynamic and GE effects are also at work: Replacing the CCs with an LTV below $\tilde{\theta}$ tigthens credit for firms in regions 1 and some of 2 and relaxes it for those in region 3 and also some of 2. Hence, consumption and investment demand rise in the first group and fall in the second and the net GE effects depend on which change is stronger. Similarly, saving incentives strengthen for the firms that are more credit constrained but weaken for those that are less credit constrained. Quantitatively, the net result is higher p and lower y and x. The reason is similar to the R-policy case: supply of inputs shrinks as firms in region 1 and some of 2 have less capital, hence input prices rise and their demand by the final goods producer falls, and this effect dominates the opposite effect coming from firms in the second group. Misallocation worsens by 4.94%, relative to the initial NCC regime, which is significantly more than in the CC case (where misallocation rises 0.11% for all firms). In terms of welfare, the LTV regime yields very small social welfare costs, much smaller than both the CC and R-policy regimes.

5 Empirical Evidence

This Section provides empirical evidence showing that the introduction of capital controls in Chile during the 1990s had effects consistent with the predictions of the model. In particular, they caused misallocation to increase for all firms and significantly more for high-productivity firms that are exporters and/or young.

5.1 Data

The empirical analysis requires three data components: a proxy for the CCs policy (the main independent variable of interest), firm-level estimates of misallocation and firm- and aggregate-level data for a set of control variables.

The Chilean capital controls were in the form of an unremunerated reserve requirement on capital inflows known as the *encaje*, introduced in June, 1991 and fully removed in September, 1998. As noted earlier, our empirical proxy for this policy is an interest-rate-equivalent of the financing cost implied by the reserve requirement, based on the methodology proposed by De Gregorio et al. (2000) (see Appendix B for details).[24] Computing it requires data on the evolution of the terms of th policy, namely the fractional reserve requirement and the length of the holding period in which the reserves had to remain at the central bank, which are reported in Table 10. It also needs a proxy for the risk-free interest rate at which the borrowed funds could have been invested abroad, for which we chose the LIBOR rate (downloaded from the *FRED Economic Data* of the St. Louis Fed). Figure 3 shows the time-series of this tax-equivalent estimate of the Chilean capital controls. It hovered around a peak of roughly 2.5% between 1994 and 1997, and averaged 1.98% over the eight years the policy was in place. The sharp, sudden increase in 1991 and removal in 1998 is crucial to identify the effects of the CCs. These fluctuations came mainly from changes in the terms of the policy (the fractional reserve requirement and the holding period) and less so from changes in the risk-free rate.

For constructing measures of misallocation and obtaining data on industry control variables, we use the manufacturing plant-level panel from Chile's *Encuesta Nacional Industrial Anual* (ENIA) for the period 1990 to 2007. The ENIA has data on all establishments with more than ten employees.[25] It includes approximately 4,500 observations per year and provides detailed information on establishments' characteristics, such as type of industry, employment, domestic sales, exports, investment, inputs, physical assets, etc.

We construct an estimate of each firm's fixed capital stock by adding cars, machinery, land and buildings. Since ENIA does not have data on the depreciation rate before 1995, we use a standard annual depreciation rate of 6% for the 1990-1994 period. Moreover, before 1992 ENIA does not report the data needed to construct this estimate of fixed capital, so we impute it using investment and the depreciation rate of 6%. To measure productivity at the establishment level, we follow Wooldridge (2009).[26] To deflate the variables used to calculate this productivity measure, we use the 4-digit NAICS code deflator and the price of capital provided by ENIA. Additionally, we use the wholesale price index and fuel price index reported by the *Instituto Nacional de Estadística* (INE) to deflate the electricity and fuel use, respectively.

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[24] See, also, Cárdenas and Barrera (1997) and Soto (1997).

[25] This restriction does not apply to firms that belong to companies that operate in more than one sector or that have more than one plant.

[26] The results are robust to computing TFP as in Levinsohn and Petrin (2003).

Misallocation is measured by first constructing MRPK estimates. We followed an approach similar to Gopinath et al. (2017) and Hsieh and Klenow (2009) by constructing MRPK as implied by our model. Rewriting condition (26), a firm's MRPK is:

$$MRPK = \frac{(\sigma - 1)}{\sigma}(p_h y_h + p_f y_f)\frac{\alpha}{k}. \tag{45}$$

We use the ENIA data on total sales for $(p_h y_h + p_f y_f)$ and tangible assets deflated by the price of capital to replace k. σ and α are taken from the calibrated model. We then follow Bai et al. (2020) to measure misallocation for a firm i in industry j at date t (MIS_{ijt}) as the absolute value of the difference between the firm's MRPK and the industry mean, in logs:

$$MIS_{ijt} = \mid Ln(MRPK_{itj}) - \overline{MRPK_{jt}} \mid,$$

where $\overline{MRPK_{jt}} \equiv E_i[ln(MRPK_{jt})]$ is the yearly industry mean. We define industries at the 4-digit ISIC code. All other firm-level variables used in the regressions below are also expressed in logs.

5.2 Panel estimation results

We estimated a set of panel regressions aim at studying how the CCs affected firm-level misallocation depending on the firms' relative TFP, their age and their exporter status. The main regression model is the following:

$$\begin{aligned} MIS_{ijt} = \omega_0 + \omega_1 CC_{t-1} * Rank\_TFP_{ijt} + \omega_2 CC_{t-1} * Young_{ijt} + \omega_3 CC_{t-1} * Exp_{ijt} \\ \omega_4 Rank\_TFP_{ijt} + \omega_5 Young_{ijt} + \omega_6 Exp_{ijt} + \omega_7 X_{ijt} + A_i + B_t + \epsilon_{ijt}, \end{aligned} \tag{46}$$

CC_{t-1} denotes the tax-equivalent capital controls, lagged one period. $Rank\_TFP_{ijt}$ corresponds to the ranking of the TFP of firm i. $Young_{ijt}$ is a dummy variable that takes the value of 1 for firms younger than ten years. For defining firms that are exporters (Exp_{ijt}) we consider two alternatives. First, L_Exp_{ijt} is a backward-looking classification that defines exporters as firms that exported at least once during the previous two years. From this perspective, exporters can be differently affected as they typically have a higher level of capital in the steady state and are more productive. The second definition, F_Exp_{ijt}, is a forward-looking classification that defines exporters as firms that reported exports at least once in the subsequent two years. This classification aims at capturing that firms that want to export in the future might have to undertake more extensive investments today, thus being more exposed to CCs.

X_{ijt} is a set of time-varying firm characteristics–i.e., fixed capital, total workers, the level of productivity, and expenditures on interest, $Int.Exp_{j,t}$. (which we include as a proxy for a firm's debt). Table 11 presents the summary statistics of these variables. A_i is a vector of firm dummy variables that account for firm fixed effects to control for time-invariant firm characteristics and B_t is a vector of time dummy variables that account for unobservables at the aggregate level that could be correlated with CC_{t-1}, which could potentially bias the results. Including these time fixed effects implies that the direct effect of CC_{t-1} remains unidentified (combined with other possible sources of time effects), since the tax-equivalent capital controls only have time variation. Standard errors are clustered at the firm level.

Table 13 presents results of four panel regressions based on the above specification. Columns (1) and (2) show results for the backward- and forward-looking definitions of exporters, respectively, both considering the full sample of firms. Columns (3) and (4) present results using only firms that existed in 1990 and fixing $Rank\_TFP_{ijt}$ to the ranking of firms in 1990, i.e., before the introduction of CCs. The similarity of results with those in Columns (1) and (2) show that the findings derived from the full sample are not driven by the possibility of endogenous firms' entry decisions. In light of this, we focus on results for the full sample in the remainder of this section (otherwise the sample size is cut almost in half).

In line with the model's quantitative predictions (see Table 4), the main insight from Table 13 is that the capital controls increased misallocation for firms' with higher relative productivity, younger firms and firms that are exporters (for both classifications considered). These are all interaction term effects because, as explained above, the direct effect of CCs is unidentified as part of the time fixed effects. The result that the coefficients for young firms are not significant when keeping the sample limited to firms that existed in 1990 is to be expected, since removing entry implies that the young-firms group is ever shrinking, which makes it very difficult to identify both their direct effect and their interaction effect with CCs.

To get closer to the structure of the quantitative experiments, Table 14 estimates simpler panel specifications that include only the interactions of CCs with young firms and exporters (and firm and time fixed effects) but breaking down the the sample in terms of the firms' relative productivity. Columns (1) to (4) split the sample into the top and bottom 50% of in productivity (showing results for both definitions of exporters), while columns (5) to (8) split the sample into the upper and lower 30% tails of the TFP distribution (and also showing results for both definitions of exporters).

This analysis provides further interesting insights in line with the model's quantitative results in Table 5. The overall pattern is the same as in Table 13 (i.e., more productive, younger and exporting firms see increases in misallocation as a result of the introduction of CCs), but some new findings emerge. As in the quantitative exercise, we find that misallocation increases significantly more for exporting, high-productivity firms, while the effect on exporting, low-productivity firms is not significantly different from zero. To better understand this result, note that while around 30% of high-productivity firms are exporters (depending on the exports and TFP classification), only 10% of firms in the low-productivity group are exporters. The result is similar regarding firms in the young group: CCs induce a larger increase in misallocation for high- than for low-productivity firms, and the effect is not statistically significant when low-productivity firms are defined as those in the 30% tail. In summary, the empirical evidence indicates that CCs contributed to increase misallocation for all firms and that the effects were stronger for high-productivity firms that are either exporters or young and not significant for low-productivity firms.

Next, we conduct a set of tests that document the robustness of the above findings. In particular, we introduce a macro variables as additional controls, conduct p-hacking tests to show that our results are not significant only for particular control variables, and estimate alternative regression specifications to conduct additional robustness check.

Interaction with macroeconomic controls: A potentially important concern is that the estimates of the interaction terms with CCs could be capturing the effect of an interaction between $Rank\_TFP_{ijt}$, $Young_{ijt}$, Lag_Exp_{ijt} or Fwd_Exp_{ijt} and other macroeconomic variables. To explore this issue, Table 15 presents the results of a set of regressions adding to the CCs interaction terms the interactions of a set of candidate macroeconomic variables (one at a time) with $Rank\_TFP_{ijt}$, $Young_{ijt}$, Lag_Exp_{ijt} or Fwd_Exp_{ijt}. The macro variables are: the LIBOR rate, inflation, growth, RER, private credit_GDP and world growth. All macroeconomic variables are lagged one period. Table 12 presents the summary statistics of these variables). Except for the interaction terms of CCs with Lag_Exp_{ijt} or Fwd_Exp_{ijt} that become statistically insignificant when interactions with growth are introduced, the rest of the CCs interaction coefficients are similar in size, sign and significance when any of the other macro controls are used.

P-Hacking tests: We also run p-hacking tests of our baseline regressions to rule out the possibility that the results are only significant for a particular set of controls. Following Brodeur et al. (2020a) and Brodeur et al. (2020b), we report t-curves and effect curves, which are t-statistics and estimated effect sizes obtained from regressions using every possible combination of control variables from the set considered Specifically, we run 4 different simulations, one for each of our dependent variables of interest. In each simulation, we perform 296 permutations which account for all the possible combinations of the remaining control variables, with the exception of the time fixed effects and the direct effect of the interacted variable which are always included.

Figure 4 presents the t-statistics by number of controls for our main independent variables, $CC * Rank\_TFP$, $CC * Young$, $CC * Lag\_Exp$, $CC * Fwd\_Exp$, based on the XX coefficient estimates for each regression. All values of t-statistics are above conventional thresholds, suggesting that the coefficient estimates are statistically significant. Overall, p-hack tests show that our main results are robust to different combinations of control variables, showing that there is no strategic selection to pick the regression specification that delivers significant coefficients.

In unreported regressions, we perform additional exercises to test the robustness of the results to alternative assumptions and specifications. For instance, one relevant concern is the potential that firms in specific industries could be driving the results. To rule examine this possibility, in two separate exercises, we check the robustness of the results to winsorizing the distribution of TFP and our measure of misallocation at the top and bottom 1%. The main coefficients of interest are robust to these modifications.

6 Conclusion

This paper examined the effects of CCs on misallocation and welfare through the lens of a dynamic general equilibrium model with heterogeneous firms, monopolistic competition, endogenous participation in external trade and financial frictions. The focus is on comparing stationary equilibria between an economy already distorted by collateral constraints and one in which CCs (an asymmetric tax on foreign debt) are added to those constraints. The episode of the Chilean *encaje* (a 30% unremunerated reserve requirement imposed between 1991 and 1998) is used as a natural experiment for exploring the model's quantitative predictions and for conducting empirical tests.

The model predicts that introducing CCs to an economy with collateral constraints affects misallocation in part via static effects (responses of firms' factor demands, production and pricing to capital controls taking as given aggregate variables and saving plans). These effects yield the result that CCs worsen misallocation by tightening the firms' financial constraints, which reduces their capital and capital-labor ratios and increases their prices. There are also, however, general equilibrium and dynamic effects induced by changes in aggregate variables (wages and the output and price of final goods) and an oversaving distortion due to stronger saving incentives as financial constraints tighthen, and some of these effects contribute to reduce misallocation. Social welfare responds to these effects on misallocation and saving, and because the effects are ambiguous in theory, quantitative analysis is necessary both to assess the potential significance of capital controls as a source of misallocation and to evaluate their social welfare implications.

The quantitative analysis is conducted by first calibrating the model so that the stationary equilibrium matches key features of Chilean data from before the introduction of the *encaje* and then solving for the new stationary equilibrium under the CCs policy. The model predicts that CCs increase misallocation slightly aggregating across all firms but at the same time misallocation increases sharply for high-productivity exporting and young firms, while it decreases for low-productivity firms. Low-productivity firms have smaller optimal scales and, consequently, need to borrow less to reach them. On the other hand, high-productivity exporting or young firms have larger optimal scales and, consequently, rely more on credit to accumulate capital and pay the fixed cost of becoming an exporter. The social welfare implications are significant. Overall, the model predicts that the adoption of the *encaje* had a sizable social welfare cost equivalent to a permanent cut of 2.39% in the consumption of all agents. The distribution of consumption across agents worsens slightly but aggregate consumption falls sharply as a result of the adverse aggregate implications of the heterogeneous increases in misallocation, which are reflected in sharp declines in GDP, wages, final goods output, aggregate investment and consumption, and higher prices of final goods (a higher real exchange rate).

The paper includes also a detailed panel empirical analysis based on firm-level data for the Chilean manufacturing sector and a tax-equivalent estimate of the value of the *encaje* as an increase in the effective interest rate on foreign borrowing. The results provide strong evidence indicating that, in line with the model's quantitative predictions, CCs increased misallocation and significantly more for exporting or young firms with high productivity.

The findings of this paper have implications beyond the analysis of capital controls. The model's theoretical predictions apply to the broader question of the effects of financial repression (i.e., situations in which interest rates differ for borrowing and lending) and also to capital income taxation. The analysis also sheds light on the misallocation, trade and real-exchange-rate implications of altering the degree of financial openness in an economy, either to reduce it as is the case with capital controls or to increase it with financial integration.

References

Alfaro, L., A. Chari, and F. Kanczuk, "The real effects of capital controls: Firm-level evidence from a policy experiment," *Journal of International Economics*, 2017, *108*, 191–210.

Andreasen, E., S. Bauducco, and E. Dardati, "Capital controls and firm performance," Mimeo 2020.

Bai, Yan, Keyu Jin, and Dan Lu, "Misallocation Under Trade Liberalization," NBER Working Papers 26188, National Bureau of Economic Research, Inc August 2020.

Beck, Thorsten, Asli Demirgüç-Kunt, and Ross Levine, "A New Database on the Structure and Development of the Financial Sector," *World Bank Economic Review*, September 2000, *14* (3), 597–605.

Bekaert, G., C. Harvey, and C. Lundblad, "Financial openness and productivity," *World Development*, 2011, *39*, 1–19.

Berthou, Antoine, John Jong-Hyun Chung, Kalina Manova, and Charlotte Sandoz Dit Bragard, "Productivity, (Mis)allocation and Trade," Mimeo 26188 2018.

Bianchi, J. and E. Mendoza, "Optimal Time-Consistent Macroprudential Policy," *Journal of Political Economy*, 2018, *126*, 588–634.

_ and _ , "A Fisherian approach to financial crises: Lessons from the Sudden Stops literature," *Review of Economic Dynamics*, 2020, *37*, S524–283.

Brodeur, Abel, Nikolai Cook, and Anthony Heyes, "Methods Matter: p-Hacking and Publication Bias in Causal Analysis in Economics," *American Economic Review*, November 2020, *110* (11), 3634–60.

_ , _ , and _ , "A Proposed Specification Check for p-Hacking," *AEA Papers and Proceedings*, May 2020, *110*, 66–69.

Buera, F. and B. Moll, "Aggregate implications of a credit crunch: the importance of heterogeneity," *American Economic Journal: Macroeconomics*, 2015, *7*, 1–42.

_ , J. Kaboski, and Y. Shin, “Finance and development: a tale of two sectors,” *American Economic Review*, 2011, *101*, 1964–2002.

Cárdenas, M. and F. Barrera, “On the effectiveness of capital controls: the experience of Colombia during the 1990s,” *Journal of Development Economics*, 1997, *54*, 27–58.

Chen, K. and A. Irarrázabal, “The role of allocative efficiency in a decade of recovery,” *Review of Economic Dynamics*, 2015, *18*, 523–550.

Darracq-Paries, M., S. Fahr, and C. Kok, “Macroprudential space and current policy trade-offs in the euro area,” in “Financial Stability Review,” European Central Bank, May 2019.

De Gregorio, J., S. Edwards, and R. Valdés, “Controls on capital inflows: do they work?,” *Journal of Development Economics*, 2000.

Domeij, David and Jonathan Heathcote, “On The Distributional Effects Of Reducing Capital Taxes*,” *International Economic Review*, 2004, *45* (2), 523–554.

Forbes, K., “One cost of the Chilean capital controls: Increased financial constraints for smaller traded firms,” *Journal of International Economics*, 2007, *71*, 294–323.

Gallego, F. and F. L. Hernández, “Microeconomic effects of capital controls: The Chilean experience during the 1990s,” *International Journal of Finance and Economics*, 2003, *8* (3), 225–253.

_ , L. Hernandez, and K. Schmidt-Hebbel, “Capital Controls in Chile: Were They Effective?,” in L. Hernandez, K. Schmidt-Hebbel, and N. Loayza, eds., *Banking, Financial Integration, and International Crises*, Vol. 3, Central Bank of Chile, 2002, chapter 12, pp. 361–412.

Gopinath, G., S. Kalemni-Ozcan, L. Karabarbounis, and C. Villegas-Sanchez, “Capital allocation and productivity in South Europe,” *Quarterly Journal of Economics*, 2017, *132*, 1915–1967.

Hsieh, Chang-Tai and Peter J. Klenow, “Misallocation and Manufacturing TFP in China and India,” *The Quarterly Journal of Economics*, 2009, *124* (4), 1403–1448.

Larraín, M. and S. Stumpner, "Capital account liberalization and aggregate productivity: The role of firm allocation," *The Journal of Finance*, 2017, *72* (4), 1825–1858.

Leibovici, F., "Financial development and international trade," Mimeo 2021.

Levinsohn, James and Amil Petrin, "Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies*, 2003.

Melitz, M., "The impact of trade on intra-industry reallocations and aggregate industry productivity," *Econometrica*, 2003, *71*, 1695–1725.

Midrigan, V. and D. Y. Xu, "Finance and misallocation: evidence from plant-level data," *American Economic Review*, 2014, *104(2)*, 422–458.

Oberfield, Ezra, "Productivity and Misallocation During a Crisis: Evidence from the Chilean Crisis of 1982," *Review of Economic Dynamics*, January 2013, *16* (1), 100–119.

Pavcnik, Nina, "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants," *The Review of Economic Studies*, 2002, *69*, 245–76.

Restuccia, Diego and Richard Rogerson, "Policy distortions and aggregate productivity with heterogeneous establishments," *Review of Economic Dynamics*, 2008, *11*, 707–720.

Simonovska, Ina and Michael E. Waugh, "The elasticity of trade: Estimates and evidence," *Journal of International Economics*, 2014, *92* (1), 34–50.

Soto, C., "Controles a los movimientos de capital: Evaluación empírica del Caso Chileno," Mimeo, Banco Central de Chile 1997.

Varela, L., "Reallocation, Competition and Productivity: Evidence from a Financial Liberalization Episode," *Review of Economic Studies*, 2018, *85*, 1279–1313.

Wooldridge, Jeffrey M., "On estimating firm-level production functions using proxy variables to control for unobservables," *Economics Letters*, September 2009, *104* (3), 112–114.

Appendix

Appendix A: The Chilean encaje

The resumption of capital flows to emerging market economies after the Latin American debt crisis of the 1980s led to a new wave of inflows to Chile starting in 1988. This surge in capital inflows exerted upward pressure on the real exchange rate, created symptoms of overheating, and made the trade-off between different macroeconomic objectives increasingly difficult and costly. As a response, in 1991, the Chilean authorities established a capital account restriction in the form of an unremunerated reserve requirement. Specifically, the capital control was an obligation to hold an unremunerated fixed-term reserve equivalent to a fraction of the capital inflow at the central bank. Hence, it was analogous to a tax per unit of time that declined with the permanence or maturity of the affected capital inflow (see Section 5.1 for a detailed derivation of the tax equivalence).[27]

We focus our analysis on the *Chilean encaje* because, for several reasons, it is a good laboratory in which to explore the firm-and industry-level consequences of capital controls. First, the *Chilean encaje* was one of the most well-known examples of market-based controls, –i.e. taxes and reserve requirements, as opposed to administrative controls with which the authority limits some specific assets, and the market is not allowed to operate. Moreover, during the 2000s, many countries, such as Colombia, Thailand, Peru and Uruguay, imposed CCs similar to the ones imposed in Chile. Second, the *Chilean encaje* was economically relevant: the total equivalent reserve deposit represented 1.9 percent of GDP during the period 1991-1998, reaching 2.9 percent of GDP in 1997 and 30 percent of that year's net capital inflows (Gallego et al. (2002)).[28] Finally, the CC period in Chile was long enough to generate sufficient variation in the data for the empirical analysis and to allow us to perform a numerical steady-state analysis. As Table 10 shows, various features of the *Chilean encaje*

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[27] The tax equivalence was made more explicit by its alternative form: foreign investors were allowed to pay the central bank an up-front fee instead of depositing the unremunerated reserve fraction with the central bank.

[28] In terms of the macroeconomic effects of the introduction of the Chilean capital control on inflows, the empirical evidence suggests that the more persistent and significant effect was on the time-structure of the capital inflows, which was tilted towards a longer maturity (see De Gregorio et al. (2000), Soto (1997), Gallego and Hernández (2003)). The policy also increased the interest rate differential (although without a significant long-run effect) and had a small effect on the real exchange rate, while there is no evidence on a significant effect on the total amount of capital inflows to the country.

were altered during its existence. These modifications, together with changes in the foreign interest rate, generated significant variability on the effective cost of the CC over time (see Figure 3).[29]

Appendix B: Tax equivalent of Chilean encaje

The introduction of the CC varies the effective interest rate faced by domestic private agents, depending on whether they want to save or borrow. If they want to save, the interest rate remains equal to the risk- free interest rate r. However, if they want to borrow, the effective interest rate they face is higher and given by $r + \nu_g$, where ν_g is the tax equivalent of the CC. In order to compute ν_g, we first need to define r_g, the interest rate ignoring risk premia for a g-months investment in Chile at which an investor makes zero profits:

$$r_g = r + \nu_g.$$

Let u be the fraction of the loan that the investor has to leave as an unremunerated reserve and h the period of time that the reserve must be kept at the Central Bank. Then, if the investment period is shorter than the reserve fixed-time–, i.e., $g < h$–, borrowing US\$1 abroad at an annual rate of r to invest at r_g in Chile for g months generates the following cash flows:

- At $t = 0$, the entrepreneur can invest $(1 - u)$ at r_g.
- At $t = g$, repaying the loan implies the following cash flow: $-(1 + r)^{g/12}$.
- At $t = h$, the reserve requirement is returned generating a cash flow u.

Therefore, the annual rate r_g at which the investor is indifferent between investing at home and abroad (computing all values as of time h, when u is returned) is:

$$(1 - u)(1 + r_g)^{g/12}(1 + r)^{(h-g)/12} + u = (1 + r)^{h/12}.$$

Solving for r_g, we find the tax-equivalent of the CC:

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[29] Although the initial coverage of the restriction was actually partial in practice, over time, authorities made a great effort to close the loopholes that allowed for evasion of controls. For instance, in 1995, the control was extended to include ADRs, and, in 1996, the rules on FDI were tightened to exclude speculative capital.

$$(1+r_g)^{g/12} = \frac{(1+r)^{g/12} - u(1+r)^{(g-h)/12}}{1-u} \equiv (1+r+\nu_g)^{g/12}.$$

If the investment horizon exceeds the term of the reserve requirement–, i.e., $h > g$–, the investor has to decide, at the end of the h-month period, whether to maintain the reserve requirement in Chile or to deposit the amount outside the country. In order to obtain closed-form solutions, we assume that the investor deposits outside the country at the risk-free interest rate. Under this assumption, the previous arbitrage condition remains the same for longer investment horizons.

Using the approximation that $(1+j)^x \approx 1+xj$, the approximate tax-equivalent is found by solving the following equation:

$$1 + gr - u(1 + (g-h)r) = (1-u)(1 + g(r+\nu_g)),$$

which yields:

$$\nu_g = r\frac{u}{1-u}\frac{h}{g}. \tag{47}$$

Appendix C: Solution Method

The solution method exploits the fact that there is no uncertainty except for the exogenous probability of death that each entrepreneur faces at the beginning of every period. This uncertainty, however, is absent from investment decisions because the annuity market perfectly insures against this event. Then, provided that we know the policy function for assets for a given region of the state space, we can perfectly recover the policies outside of this region by using the first order conditions and the constraints of the problem. To see this, we re-write these here:

- F.O.C. n:

$$-\lambda w + \gamma \left((1-\alpha) z k^{\alpha} n^{-\alpha} \right) = 0 \tag{48}$$

- F.O.C. k:

$$-\lambda p(\hat{r}+\delta) - \mu(1+\hat{r}-\theta) + \gamma z \alpha k^{\alpha-1} n^{1-\alpha} = 0 \tag{49}$$

- F.O.C. p_h:

$$p_h = \frac{\gamma\sigma}{\lambda(\sigma-1)} \tag{50}$$

- F.O.C. p_f:

$$p_f = \frac{\tau\gamma\sigma}{\lambda(\sigma-1)} \tag{51}$$

- F.O.C. c:

$$p\lambda = c^{-\gamma} \tag{52}$$

- Budget constraint:

$$pc + pa'(1-\rho) + pk(\hat{r}+\delta) + wn + wF\mathbb{I}_{e=0,e'=1} = w + \frac{p_h^{1-\sigma}}{p^{-\sigma}} y + \frac{p_f^{1-\sigma}}{\bar{p}^{*-\sigma}} \bar{y}^* + pa(1+\hat{r}) - T, \tag{53}$$

- Production function:

$$\left(\frac{p_h}{p}\right)^{-\sigma} y + \tau \left(\frac{p_f}{p^*}\right)^{-\sigma} \bar{y}^* = z k^{\alpha} n^{1-\alpha} \tag{54}$$

- Collateral constraint:

$$k(1+\hat{r}-\theta) \leq (1+\hat{r})a \tag{55}$$

- Euler equation:

$$c^{-\gamma} = \beta(1+\hat{r})(c'^{-\gamma}+\lambda') \tag{56}$$

where λ is the Lagrange multiplier associated to the collateral constraint (55). Primed variables indicate they are next period's.

The algorithm consists of the following steps:

1. Given prices and aggregate quantities p, w, y, solve for the optimal long-run levels of capital k_{ss} and labor n_{ss} for a firm with productivity z by solving the system of equations given by (48), (49), (50), (51) and (54) and noticing that the collateral constraint does not bind once the firm reaches its optimal scale.
2. For a state space interval $[a_{min}; a_{upper}]$ where $a_{min} = k_{ss}$ and a_{upper} is a desired level of assets such that $a_{upper} > a_{min}$, compute the policy functions of the problem of exporters and non-exporters by a global solution method. For the exercise at hand, we use the endogenous grid method.
3. Obtain the trajectories of variables for $a^f > a_{upper}$, using the fact that $k^f = k_{ss}$, $n^f = n_{ss}$, $\mu^f = 0$, from equations (53) and (56).
4. Obtain the trajectories of variables for $a^b < a_{min}$. Two possible situations arise here:
    (a) There is no capital control: in this case, the collateral constraint (55) binds for all $a^b < a_{min}$. Then, setting $c' = c_{min}$, $\mu' = 0$, from (56) we can recover c. From (48), (50), (51), (53), (54) and (55) we can obtain a, k and n. Using (49) we obtain μ. In this fashion, the policy function $a' = f(a; z)$ for $a < a_{min}$ is computed.

    (b) There is a capital control: in this case, the firm accumulates capital through debt paying an interest rate of $\hat{r} = r + \mu > r$ until reaching k_{ss}^{cc}, which would be the optimal scale for the firm if this was the symmetric interest rate it faced.[30] From then onwards, $\hat{r}$ is too high for the firm to continue financing investment through

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[30] k_{ss}^{cc} can be obtained in a similar fashion as k_{ss}.

debt, so it starts repaying debt until $d = 0$. Given that from then onwards the relevant interest rate for the firm is r, the firm starts accumulating capital through self-financing until $k = k_{ss}$.[31] Taking into account the behavior of investment and debt just described, the policy function $a' = f(a; z)$ for $a < a_{min}$ is computed in a similar fashion as before.

5. At every point of the state variable space, check whether $G(a', e' = 1; z, e = 0) > G(a', e' = 0; z, e = 0)$. If so, the firm becomes an exporter at that point and remains an exporter for all a larger than that.

6. Iterate on $1 - 5$ until p, w, y are such that the labor market, the markets for domestic varieties and the final-good market clear.

Appendix D: Derivation of Marginal Revenue Products

A firm's revenue is defined by the value of its sales: $RV \equiv p_h y_h + p_f y_f$. Hence, the MRPs of labor and capital are given by $MRPN \equiv \delta RV/\delta n$ and $MRPK \equiv \delta RV/\delta k$, respectively. The results for the two MRPs used in conditions (25) and (26) were obtained as follows.

First, taking derivatives of RV with respect to n and k,we obtain:

$$MRPN = [p_h + y_h(\delta p_h/\delta y_h)](\delta y_h/\delta n) + [p_f + y_f(\delta p_f/\delta y_f)](\delta y_f/\delta n) \tag{57}$$

$$MRPK = [p_h + y_h(\delta p_h/\delta y_h)](\delta y_h/\delta k) + [p_f + y_f(\delta p_f/\delta y_f)](\delta y_f/\delta k) \tag{58}$$

Solving the demand functions faced by the entrepreneur (2)-(3) for p_h and p_f, respectively, yields $p_h = (y_h/y)^{-1/\sigma} p$ and $p_f = (y_f/y^*)^{-1/\sigma} p^*$, and from these expressions we obtain:

$$\frac{\delta p_h}{\delta y_h} = \frac{-1}{\sigma}\left(\frac{y_h}{y}\right)^{-(\frac{1}{\sigma})-1}\frac{p}{y}, \qquad \frac{\delta p_f}{\delta y_f} = \frac{-1}{\sigma}\left(\frac{y_f}{y^*}\right)^{-(\frac{1}{\sigma})-1}\frac{p^*}{y^*}, \tag{59}$$

which multipliying by y_h and y_f, respectively, and simplifying yields:

$$\frac{\delta p_h}{\delta y_h} = \frac{-p_h}{\sigma}, \qquad \frac{\delta p_f}{\delta y_f} = \frac{-p_f}{\sigma}, \tag{60}$$

Substituting these expressions into (57)-(58) and simplifying using the equilibrium condition

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[31] In this region of the state space, an extra equilibrium condition is that $d \leq 0$.

$p_f = \tau p_h$ we obtain:

$$MRPN = \frac{p_h}{\varsigma}\left(\frac{\delta y_h}{\delta n} + \tau\frac{\delta y_f}{\delta n}\right), \qquad MRPK = \frac{p_h}{\varsigma}\left(\frac{\delta y_h}{\delta k} + \tau\frac{\delta y_f}{\delta k}\right), \tag{61}$$

where, as defined in the paper, $\varsigma = \sigma/(\sigma - 1)$.

Now differentiate the market-clearing condition $y_h + \tau y_f = zk^\alpha n^{1-\alpha}$ with respect to n and with respect to k to obtain:

$$\frac{\delta y_h}{\delta n} + \tau\frac{\delta y_f}{\delta n} = z(1-\alpha)\left(\frac{k}{n}\right)^\alpha, \qquad \frac{\delta y_h}{\delta k} + \tau\frac{\delta y_f}{\delta k} = z\alpha\left(\frac{n}{k}\right)^{1-\alpha} \tag{62}$$

Substituting these results into those obtained in (61) yields the expressions used in conditions (25) and (26) of the paper:

$$MRPN = \frac{p_h}{\varsigma}z(1-\alpha)\left(\frac{k}{n}\right)^\alpha, \tag{63}$$

$$MRPK = \frac{p_h}{\varsigma}z\alpha\left(\frac{n}{k}\right)^{1-\alpha}. \tag{64}$$

Appendix F: Proofs

Proof of Proposition 2

Proof. The planner's problem can be written as:

$$\max_{\{c_q, n_q, x_q, k'_q, y_{h,q}, y_{f,q}\}_{i\in\mathcal{S}}} \int_{\mathcal{S}} \xi_q \sum_{t=0}^{\infty} [\beta(1-\rho)]^t U(c_{q,t})\phi(q)dq$$

s.t.

$$\int_{\mathcal{S}} [c_{q,t} + x_{q,t}]\phi(q)dq = y_t \quad \forall t, \tag{65}$$

$$\left[\int_0^1 y_{h,t}(i)^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} = y_t \quad \forall t, \tag{66}$$

$$y_{h,t}(i) + \tau y_{f,t}(i) = z_i k_{i,t}^\alpha n_{i,t}^{1-\alpha} \quad \forall i, \forall t, \tag{67}$$

$$k_{i,t+1} = \frac{1}{1-\rho}((1-\delta)k_{i,t} + x_{i,t}) \quad \forall i, \forall t, \tag{68}$$

$$\int_{\mathcal{S}} n_{q,t}\phi(q)dq = 1 \quad \forall t, \tag{69}$$

$$\int_0^1 p_{f,t}(i)y_{f,t}(i)di - p_{m,t}y_{m,t} = \overline{TBD} \quad \forall t, \tag{70}$$

$$y_{f,i}(i) = \left(\frac{p_{f,t}(i)}{p^*}\right)^{-\sigma} y^* \quad \forall i, \forall t. \tag{71}$$

Equation (70) represents the trade balance of this economy, where $\overline{TBD}$ is a given level of trade balance deficit, and equation (71) is the foreign demand for domestic varieties. After some algebra, the planner's problem becomes

$$\max_{\{c_q, n_q, x_q, k'_q, y_{h,q}, y_{f,q}\}_{i\in\mathcal{S}}} \int_{\mathcal{S}} \xi_q \sum_{t=0}^{\infty} [\beta(1-\rho)]^t U(c_{q,t})\phi(q)dq$$

s.t.

$$\int_{\mathcal{S}} [c_{q,t} + (1-\rho)k_{q,t+1} - (1-\delta)k_{q,t}]\phi(q)dq = \left[\int_0^1 (z_i k_{i,t}^{\alpha} n_{i,t}^{1-\alpha} - \tau y_{f,t}(i))^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \quad \forall t, \tag{72}$$

$$\int_{\mathcal{S}} n_{q,t}\phi(q)dq = 1 \quad \forall t, \tag{73}$$

$$y^{*1/\sigma} p^* \int_0^1 y_{f,t}(i)^{\frac{\sigma-1}{\sigma}} di - p_{m,t}y_{m,t} = \overline{TBD} \quad \forall t, \tag{74}$$

Assuming $\xi_i = \xi_j$ for all $i, j \in \mathcal{S}$, the FOC of the planner with respect to capital reads:

$$\lambda_t = \beta\lambda_{t+1}\left[(1-\delta) + \left[\int_0^1 (z_i k_{i,t}^{\alpha} n_{i,t}^{1-\alpha} - \tau y_{f,t}(i))^{\frac{\sigma-1}{\sigma}} di + y_{m,t}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}} \left(z_i k_{i,t}^{\alpha} n_{i,t}^{1-\alpha} - \tau y_{f,t}(i)\right)^{\frac{-1}{\sigma}} z_i \alpha \left(\frac{n_{i,t}}{k_{i,t}}\right)^{1-\sigma}\right]$$

$\forall t$, $\forall i$. After some algebra, this expression becomes

$$\lambda_t = \beta\lambda_{t+1}\left[(1-\delta) + \left(\frac{y_t}{y_{h,t}(i)}\right)^{1/\sigma} \frac{\alpha}{k_{i,t}} \left(y_{h,t}(i) + \tau y_{f,t}(i)\right)\right] \quad \forall i, \forall t.$$

Notice that, from equation (64) and using (2), we can write

$$\lambda_t = \beta\lambda_{t+1}\left[(1-\delta) + \frac{MRPK_{i,t}}{p}\frac{\sigma}{\sigma-1}\right] \quad \forall i, \forall t.$$

This condition needs to hold for every $i \in \mathcal{S}$. Then,

$$MRPK_i = MRPK_j \quad \forall i, j \in \mathcal{S}$$

□

Appendix E: Figures and Tables

Figure 2: Welfare in 1-Sector Model

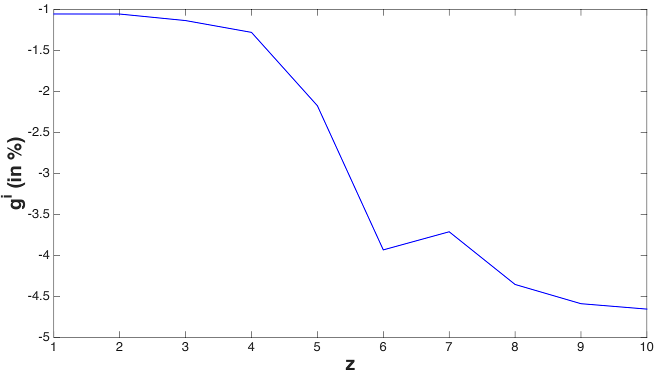
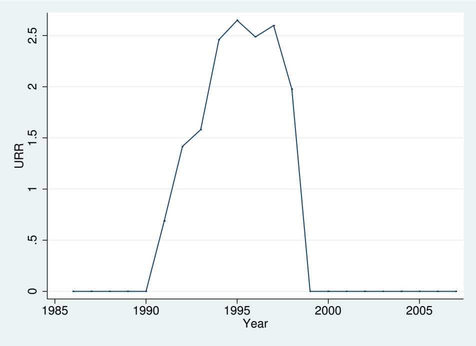
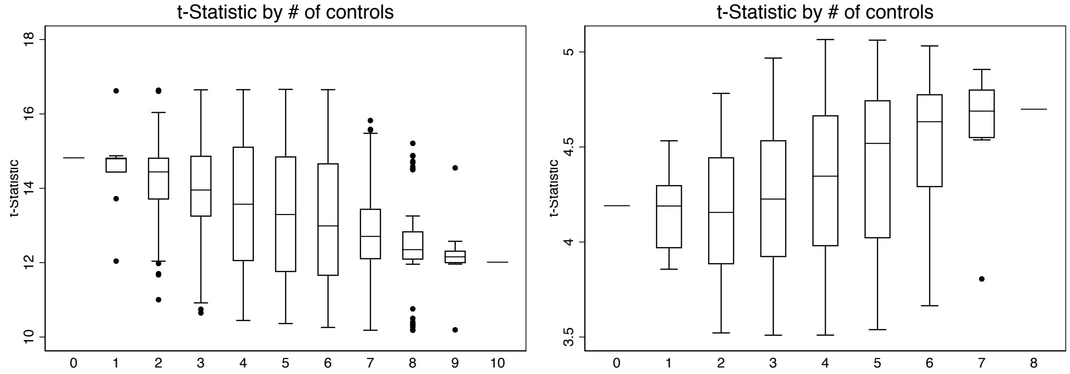


Figure 3: The tax equivalent of the *Chilean encaje*

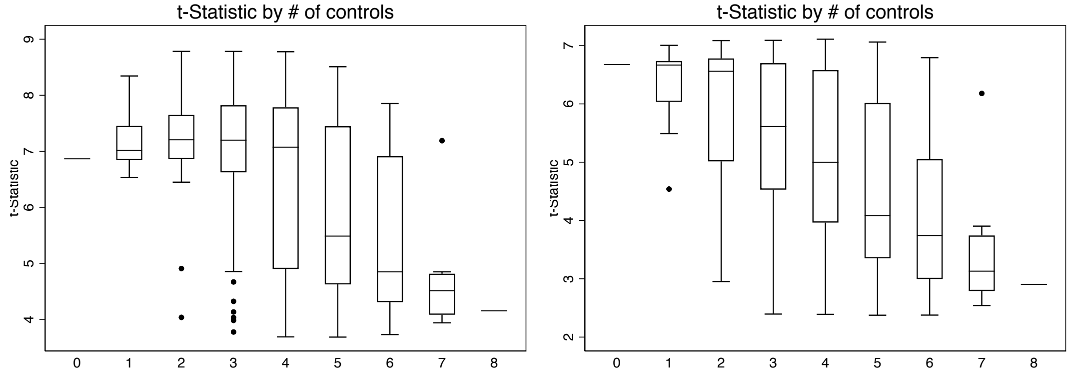


Note: We calculate the tax equivalent following the methodology in De Gregorio et al. (2000) .

Figure 4: P-Hacking tests



(a) $CC * Rank\_TFP$ (b) $CC * Young$



(c) $CC * Lag\_Exp$ (d) $CC * Fwd\_Exp$

Notes: This figure presents the t-statistics by number of controls for our main independent variables of interest, in Graph A through D are $CC * Rank\_TFP$, $CC * Young$, $CC * Lag\_Exp$, $CC * Fwd\_Exp$, based on 296 combinations of control variables for each regression where the dependent variable in all cases is misallocation, defined as the absolute value of the difference between the firm's MRPK to the mean of the industry.

Table 1: Parameter Values

Predetermined parameters				Calibrated parameters		
β	Discount factor	0.96	Standard	τ	Iceberg trade cost	5.127
γ	Risk aversion	2	Standard	σ_z	Productivity dispersion	0.435
σ	Substitution elasticity	4	Leibovici (2021)	F	Sunk export entry cost	1.350
δ	Depreciation rate	0.06	Midrigan and Xu (2014)	θ	Collateral constraint	0.136
ν	Death probability	0.08	Chilean data	$\underline{a}$	Fraction of SS capital as initial net worth	0.252
				α	Capital intensity	0.354

Table 2: Moments

Target Moment	Data (1990-1991) (1)	Model (No C.controls) (2)
Share of exporters	0.18	0.18
Average sales (exporters/non-exporters)	8.55	8.44
Average sales (age 5 / age 1)	1.26	1.39
Aggregate exports / sales	0.21	0.20
Aggregate credit / Value added	0.20	0.20
Aggregate capital stock / wage bill	6.60	6.70

Table 3: Aggregate effects of the CC

	Model w/o Lump sum (Δ%) (1)	Model with Lump-sum (Δ%) (2)
Exports	2.0%	1.8%
Share of exporters	−8.0%	−6.9%
Domestic Sales	−3.6%	−3.2%
Investment	−4.4%	−4.1%
Consumption	−2.7%	−2.4%
Final goods output	−3.0%	−2.7%
Real GDP	−1.7%	−1.5%
Wage	−2.6%	−2.4%
Price (Real ex. rate)	−1.4%	−1.2%

Table 4: Dev MRPK from efficient level

	% change	G (%)
All firms	0.11%	−2.39%
Low z	−0.79%	−1.65%
High z	0.38%	−3.52%
Exporters	5.34%	—
Non-exporters	−1.53%	—
Young	0.04%	—
Old	$\simeq 0\%$	—

Table 5: Dev MRPK from efficient level, by level of z

	% change
Exporters, low z	—
Exporters, high z	5.34%
Non-exporters, low z	−0.79%
Non-exporters, high z	−2.73%
Young, low z	−0.83%
Young, high z	0.38%
Old, low z	$\simeq 0\%$
Old, high z	$\simeq 0\%$

Table 6: Welfare: Distributional Effects

	$G(\%)$	$G^a(\%)$	$G^d(\%)$
All firms	−2.39%	−2.70%	0.33%
Low z	−1.65%	−1.35%	−0.30%
High z	−3.52%	−3.36%	−0.17%

Table 7: Dev MRPK from efficient level, with lump sum transfers

	% change	G (%)
All firms	0.19%	−2.14%
Low z	−0.63%	−1.51%
High z	0.44%	−3.12%
Exporters	4.72%	—
Non-exporters	−1.25%	—
Young	0.13%	—
Old	$\simeq 0\%$	—

Table 8: Dev MRPK from efficient level, with symmetric R

	% change	G (%)
All firms	7.53%	−2.74%
Low z	6.61%	−2.69%
High z	7.80%	−2.81%
Exporters	19.95%	—
Non-exporters	5.55%	—
Young	7.47%	—
Old	$\simeq 0\%$	—

Table 9: Dev MRPK from efficient level, decrease in θ

	% change	G (%)
All firms	4.94%	−0.16%
Low z	6.06%	−0.28%
High z	4.61%	0.04%
Exporters	5.15%	—
Non-exporters	5.75%	—
Young	5.01%	—
Old	$\simeq 0\%$	—

Table 10: Main changes in the administration of the *Chilean encaje*

Jun-1991	20% URR introduced for all new credit Holding period (months)=min(max(credit maturity, 3),12) Holding currency=same as creditor Investors can waive the URR by paying a fix fee (Through a repo agreement at discount in favor of the central bank) Repo discount= US$ libor
Jan-1992	20% URR extended to foreign currency deposits with proportional HP
May-1992	Holding period (months)=12 URR increased to 30% for bank credit lines
Aug-1992	URR increased to 30% Repo discount= US$ libor +2.5
Oct-1992	Repo discount= US$ libor +4.0
Jan-1995	Holding currency=US$ only
Sep-1995	Period to liquidate US$ from Secondary ADR tightened
Dec-1995	Foreign borrowing to be used externally is exempt of URR
Oct-1996	FDI committee considers for approval productive projects only
Dec-1996	Foreign borrowing <US$ 200,000 (500,000 in a year) exempt of URR
Mar-1997	Foreign borrowing <US$ 100,000 (100,000 in a year) exempt of URR
Jun-1998	URR set to 10%
Sep-1998	URR set to zero

Note: URR=Unremunerated Reserve Requirement
Source: De Gregorio et al. (2000).

Table 11: Summary statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Fixed Capital	92,690	11.39	2.771	0	22.47
Total Workers	92,690	3.578	1.112	0	8.656
Interest Expenditures	92,690	4.895	4.675	0	18.24
TFP	92,690	2.151	0.149	-3.536	2.858
L_Exp	92,690	0.334	0.472	0	1
F_Exp	92,690	0.195	0.396	0	1
ln_mrpk	92,690	-0.633	2.040	-6.479	13.37
Misallocation	92,690	4.715	3.127	0	17.72
Rank_TFP	92,690	2,584	1,502	1	5,765
Young	92,690	0.486	0.500	0	1
Number of id	12,155	12,155	12,155	12,155	12,155

Table 12: Summary Statistics: Macroeconomic Indicators 1990-2007

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
CC	18	0.881	1.109	0	2.649
Inflation	18	0.017	0.536	-0.626	1.887
RER_dev	18	-0.009	0.055	-0.082	0.113
Growth	18	0.055	0.028	-0.021	0.120
World Growth	18	3.054	1.000	1.369	4.476
Private Credit/GDP	18	0.613	0.107	0.442	0.743
Libor 12m	18	4.918	1.799	1.364	8.415

Note: Capital Controls are calculated following the methodology of De Gregorio et al. (2000). Inflation, RER_dev, Growth and World Growth are from the Central Bank of Chile. RER_dev is calculated as the yearly variation of the real exchange rate, which is defined as the inverse of the nominal exchange rate multiplied by an international price index relevant for Chile and deflated by the chilean price index. The Private Credit to GDP ratio is from the Financial Structure Database (see Beck et al. (2000)). The 12-month Libor interest rate is obtained from the FRED Economic Data.

Table 13: Heterogeneous effects of CC on Misallocation: TFP, Age and Export status

VARIABLES	(1) All Firms	(2) All Firms	(3) Firms in 1990	(4) Firms in 1990
CC*Rank_TFP	0.009***	0.009***	0.000***	0.000***
	(0.001)	(0.001)	(0.000)	(0.000)
CC*Young	0.080***	0.094***	0.017	0.042
	(0.020)	(0.020)	(0.041)	(0.040)
CC*L_Exp	0.087***		0.137***	
	(0.021)		(0.033)	
CC*F_Exp		0.078***		0.060*
		(0.027)		(0.035)
Rank_TFP	-0.024***	-0.024***	-0.001***	-0.001***
	(0.005)	(0.005)	(0.000)	(0.000)
Young	-0.123**	-0.134**	-0.042	-0.074
	(0.055)	(0.054)	(0.091)	(0.091)
L_Exp	-0.125***		-0.289***	
	(0.037)		(0.063)	
F_Exp		-0.082		-0.076
		(0.051)		(0.067)
TFP	-4.521***	-4.515***	-5.108***	-5.114***
	(0.596)	(0.596)	(0.524)	(0.525)
Total Workers	-0.502***	-0.503***	-0.548***	-0.557***
	(0.033)	(0.033)	(0.046)	(0.046)
Fixed Capital	0.482***	0.481***	0.534***	0.532***
	(0.015)	(0.015)	(0.023)	(0.023)
Interest Expenditures	0.007**	0.007**	0.008**	0.008**
	(0.003)	(0.003)	(0.004)	(0.004)
Constant	13.332***	13.336***	15.348***	15.338***
	(1.162)	(1.160)	(1.110)	(1.114)
Observations	92,690	92,690	50,403	50,403
R-squared	0.123	0.123	0.105	0.105
Number of id	12,155	12,155	4,521	4,521
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES

Note: This table examines the effect of the interaction of CC with Rank_TFP, Young, L_Exp and F_Exp on misallocation, defined as the absolute value of the difference between the firm's MRPK to the mean of the industry. Columns (1) and (2) consider the full sample of firms while columns (3) and (4) present the results when only considering firms that existed in 1990 in order to fix the $Rank_TFP_{ijt}$ to the ranking that firms had in 1990, i.e., before the introduction of the CC. All regressions include a constant term, firm and time fixed effects, and robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.

Table 14: Heterogeneous effects of CC on Misallocation: Age and Export status by productivity.

VARIABLES	(1) All Firms young	(2) All Firms young	(3) All Firms young	(4) All Firms young	(5) All Firms young	(6) All Firms young	(7) All Firms young	(8) All Firms young	(9) All Firms young	(10) All Firms young	(11) All Firms young
URR_rank_tfp_isic	0.012***	0.009***	0.009***	0.026***	-0.006*	0.017***	0.002	0.031***	-0.003	0.028***	-0.003
	(0.003)	(0.003)	(0.003)	(0.006)	(0.003)	(0.006)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
CC*Young	0.097***	0.076***	0.101***	0.153***	0.070***	0.145***	0.082***				
	(0.020)	(0.021)	(0.020)	(0.051)	(0.023)	(0.055)	(0.021)				
CC*L_Exp		0.138***						0.080***	0.132***		
		(0.021)						(0.021)	(0.029)		
Young	-0.133**	-0.114**	-0.136**	-0.091	-0.120**	0.059	-0.186***				
	(0.054)	(0.055)	(0.054)	(0.136)	(0.060)	(0.143)	(0.058)				
L_Exp		-0.170***									
		(0.037)									
TFP	-5.014***	-5.010***	-4.999***	-5.601***	-4.731***	-7.317***	-4.646***	-4.985***	-4.606***	-4.984***	-4.620***
	(0.532)	(0.531)	(0.530)	(0.572)	(0.724)	(0.592)	(0.564)	(0.331)	(0.924)	(0.330)	(0.927)
Total Workers	-0.517***	-0.510***	-0.511***	-0.493***	-0.539***	-0.495***	-0.560***	-0.490***	-0.528***	-0.492***	-0.528***
	(0.033)	(0.033)	(0.033)	(0.059)	(0.042)	(0.071)	(0.038)	(0.047)	(0.048)	(0.047)	(0.048)
Fixed Capital	0.478***	0.478***	0.477***	0.351***	0.535***	0.330***	0.514***	0.415***	0.569***	0.412***	0.569***
	(0.015)	(0.015)	(0.015)	(0.025)	(0.018)	(0.032)	(0.016)	(0.019)	(0.025)	(0.019)	(0.025)
Interest Expenditures	0.008**	0.008**	0.008**	0.008	0.009**	0.005	0.007**	0.006	0.007	0.005	0.007
	(0.003)	(0.003)	(0.003)	(0.006)	(0.004)	(0.007)	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)
rank of (ln_tfp) by ind1_year	-0.055***				-0.033	-0.019	-0.049**	-0.088***	-0.045	-0.085***	-0.045
	(0.018)				(0.024)	(0.023)	(0.019)	(0.015)	(0.030)	(0.015)	(0.030)
CC*F_Exp			0.150***								
			(0.027)								
F_Exp			-0.146***								
			(0.051)								
Constant	14.136***	14.102***	14.117***	16.962***	12.940***	20.495***	13.199***	14.696***	12.134***	14.797***	12.159***
	(1.078)	(1.077)	(1.074)	(1.235)	(1.443)	(1.310)	(1.130)	(0.709)	(1.861)	(0.707)	(1.868)
Observations	92,690	92,690	92,690	30,965	61,725	20,058	72,632	45,062	47,628	45,062	47,628
R-squared	0.124	0.125	0.124	0.114	0.117	0.119	0.127	0.127	0.105	0.127	0.105
Number of id	12,155	12,155	12,155	9,147	9,257	2,896	12,155	8,980	5,380	8,980	5,380
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: This table examines the effect of the interaction of CC with Young, L_Exp and F_Exp on misallocation,defined as the absolute value of the difference between the firm's MRPK to the mean of the industry, while dividing the sample according to the firms' TFP ranking. Columns (1) to (4) divide the sample at its median while columns (5) to (8) consider the upper and lower 30% tails. All regressions include a constant term, firm and time fixed effects, and robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.

Table 15: Interaction with macroeconomic controls

VARIABLES	(1) Libor	(2) Libor	(3) Inflation	(4) Inflation	(5) Growth	(6) Growth	(7) RER	(8) RER	(9) PrivCreditGDP	(10) PrivCreditGDP	(11) WorldGrowth	(12) WorldGrowth
CC*Rank_TFP	0.009***	0.009***	0.009***	0.009***	0.010***	0.010***	0.005***	0.005***	0.011***	0.011***	0.009***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CC*Young	0.083***	0.095***	0.085***	0.095***	0.096***	0.097***	0.081***	0.094***	0.074***	0.094***	0.066***	0.085***
	(0.021)	(0.020)	(0.021)	(0.020)	(0.021)	(0.021)	(0.021)	(0.020)	(0.022)	(0.021)	(0.021)	(0.020)
CC*L_Exp	0.081***		0.087***		0.042*		0.084***		0.103***		0.103***	
	(0.022)		(0.021)		(0.023)		(0.024)		(0.023)		(0.021)	
CC*F_Exp		0.071***		0.078***		0.023		0.077**		0.081***		0.105***
		(0.027)		(0.027)		(0.029)		(0.032)		(0.029)		(0.027)
Young*Libor	0.002	0.002										
	(0.006)	(0.006)										
L_Exp*Libor	0.016											
	(0.011)											
Rank_TFP*libor	-0.001***	-0.001***										
	(0.000)	(0.000)										
F_Exp*Libor		0.036***										
		(0.013)										
Young*Inflation			-0.003	-0.003								
			(0.003)	(0.003)								
L_Exp*Inflation			0.004									
			(0.004)									
Rank_TFP*Inflation			-0.001***	-0.001***								
			(0.000)	(0.000)								
F_Exp*Inflation				0.008								
				(0.005)								
Young*Growth					-0.008	-0.002						
					(0.005)	(0.005)						
L_Exp*Growth					0.042***							
					(0.009)							
Rank_TFP*Growth					-0.001***	-0.001***						
					(0.000)	(0.000)						
F_Exp*Growth						0.057***						
						(0.010)						
Young*RER							-0.000	-0.000				
							(0.000)	(0.000)				
L_Exp*RER							-0.000					
							(0.003)					
Rank_TFP*RER							-0.001***	-0.001***				
							(0.000)	(0.000)				
F_Exp*TCR								0.000				
								(0.004)				
Young*PrivCreditGDP									0.021	-0.006		
									(0.063)	(0.064)		
L_Exp*PrivCreditGDP									0.417			
									(0.300)			
Rank_TFP*PrivCreditGDP									0.083***	0.081***		
									(0.011)	(0.011)		
F_Exp*PrivCreditGDP										0.296		
										(0.383)		
Young*WorldGrowth											0.005	0.014
											(0.011)	(0.011)
L_Exp*WorldGrowth											0.205***	
											(0.023)	
Rank_TFP*WorldGrowth											0.006***	0.005***
											(0.001)	(0.001)
F_Exp*WorldGrowth												0.322***
												(0.026)
Observations	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690	92,690
R-squared	0.123	0.123	0.124	0.124	0.123	0.124	0.124	0.124	0.124	0.124	0.125	0.125
Number of id	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155	12,155
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table examines the robustness of the interaction of CC with Rank_TFP, Young, L_Exp and F_Exp on misallocation when introducing, one at a time, the interactions of macroeconomic variables and our variables of interest, $rank_TFP_{ijt}$, $Young_{ijt}$, L_Exp_{ijt} or F_Exp_{ijt}. The macroeconomic variables under consideration are: the Libor rate, inflation, growth, RER, private credit_GDP and world growth. All macroeconomic variables are lagged one period. All regressions include a constant term, firm and time fixed effects, and robust standard errors. T-statistics in parenthesis. ***, **, and * indicate significance at the 1%,5%, and 10% level.